Ecological risk assessment of the St. Anns Bank Area of Interest

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ABSTRACT

An ecological risk assessment was conducted for the St. Anns Bank Area of Interest (AOI) to establish the relative risks presented by a variety of human activities to the conservation priorities for the future Marine Protected Area (MPA). Activities considered in the assessment were limited to those that currently occur within the AOI (fisheries and marine transportation) and those which may occur within the near future (oil and gas exploration). The risk assessment approach combined the consequence of an event (i.e., predicted impact of an interaction) with the likelihood of its occurrence. The findings of this assessment have contributed to decision-making on activities that would be allowed under the regulations within the MPA, and have also helped inform the design of the final boundary and locations of the limited fishing zones.

RÉSUMÉ

Une évaluation du risque écologique a été effectuée pour la zone d'intérêt (ZI) du banc de Sainte-Anne afin de déterminer les risques relatifs causés par diverses activités humaines aux priorités de conservation de la future zone de protection marine (ZPM). Les activités étudiées dans l'évaluation ont été limitées à celles qui se pratiquent déjà dans la ZI (pêche et transport maritime) et à celles qui pourraient s'y pratiquer dans un proche avenir (exploration pétrolière et gazière). L'approche de l'évaluation du risque a consisté à combiner la conséquence d'un événement (c.-à-d. la répercussion prévue d'une interaction) avec la probabilité de sa réalisation. Les conclusions de cette évaluation ont contribué à la prise de décision concernant les activités qui seraient autorisées dans la ZPM en vertu du Règlement. Elles ont également aidé à déterminer le tracé définitif des limites de la zone et les emplacements des secteurs où la pêche sera limitée.

1.0 INTRODUCTION

1.1 Background

On June 8, 2011, the St. Anns Bank Area of Interest (AOI) was announced by Fisheries and Oceans Canada Minister Keith Ashfield, signalling the beginning of the process to establish this area as a Marine Protected Area (MPA) under Canada's *Oceans Act*. The St. Anns Bank AOI was identified in a broad spatial conservation analysis for the Scotian Shelf and Bay of Fundy. This was part of an effort to identify a potential MPA network for the offshore portions of Fisheries and Oceans Canada's (DFO's) Maritimes Region (Horsman et al., 2011). Using this analysis, St. Anns Bank, along with two other areas, was identified in 2009 as a candidate Area of Interest. A public consultation process followed, and DFO gathered feedback on each site, selecting St. Anns Bank for a combination of ecological reasons and support from the public and stakeholders. The St. Anns Bank AOI is located east of Cape Breton Island (Figure 1.1-1). The AOI boundaries cover approximately 5100 km^2 and include Scatarie Bank, most of St. Anns Bank, and part of the western edge of the Laurentian Channel. The boundaries reflect a general study area for the MPA establishment process and should not be considered as the future MPA boundaries.

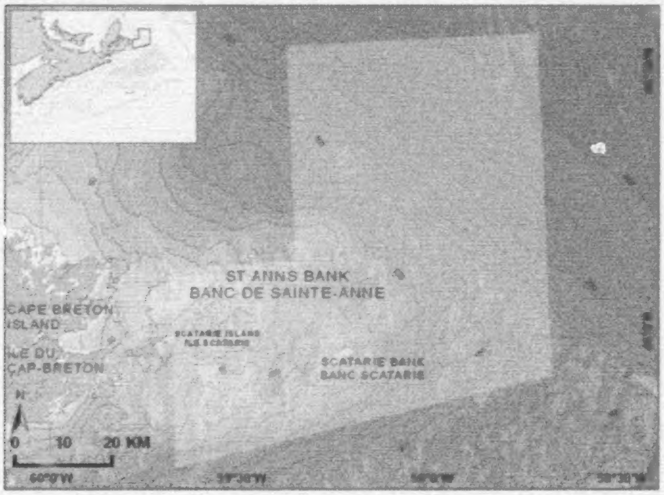

Figure 1.1 - 1. The St. Anns Bank Area of Interest. The boundaries for the proposed marine protected area shown on this map are for information, study and consultation purposes only.

<u>The MPA Establishment Process</u>

Following the initial consultation phase to select an Area of Interest, the process for establishing and managing *Oceans Act* MPAs includes the following steps[1]:

- Step 1: Select an AOI

[1] For more information on the establishment and management of MPAs under the *Oceans Act* see: http://www.dfo-mpo.gc.ca/oceans/marineareas-zonesmarines/mpa-zpm/process-processus-eng.htm.

- Step 2: Conduct an Overview and Assessment of the AOI
- Step 3: Develop Regulatory Intent
- Step 4: Develop the Regulatory Documents
- Step 5: Manage the MPA

After the AOI was selected, an Ecosystem Overview Report (Ford and Serdynska, 2013) was drafted to summarize the ecological significance of the site, and several other overview reports (i.e., Fisheries Overview, Marine Transportation Overview, Traditional Use study, Mineral Assessment) have been produced to describe the social, cultural, and commercial activities relevant to the site. This ecological risk assessment contributes to the assessment component of Step 2 of MPA establishment by examining the impacts of human activities on the conservation priorities for the future MPA.

1.2 Risk Assessment Overview

The International Organization for Standardization (ISO) notes that "Risk is often expressed in terms of a combination of the consequences of an event…and the associated likelihood of occurrence" (Section 2.1 Note 4; ISO, 2009), where likelihood is the chance of something happening and the consequence is the outcome of the event should it occur (ISO, 2009). Both likelihood and consequence can be expressed in qualitative or quantitative terms, depending on data availability (Hobday et al., 2011).

A risk assessment provides a structured, evidence-based process to analyse risk for informed decision-making (ISO, 2009). Fisheries and Oceans Canada employs a range of models and approaches for assessing ecological risk from various human impacts. For fisheries management purposes, stock assessments can be used to develop quantitative descriptions of risk associated with different management actions. Qualitative risk assessment frameworks have also been developed for assessing risk from habitat-altering activities (DFO, 2010a), fishing activities in sensitive areas (DFO, 2012a), and to identify priorities for ecosystem-based oceans management (DFO, 2012b). The qualitative ecological risk assessment approach developed for St. Anns Bank drew upon these DFO models and expert advice provided through a Canadian Science Advisory Process (DFO 2012c), with an emphasis on the use of spatial data to support the analyses.

1.3 Objectives

Oceans Act MPA regulations are designed to meet a set of site-specific conservation objectives. MPA regulations typically include general prohibitions to prevent removal or harm to species and/or habitats, some form of zoning scheme, activity approval requirements (e.g., for research, recreation), and exceptions to the regulations (e.g., national security, certain fishing activities that are considered low impact). Many *Oceans Act* MPAs also include at least one highly restricted zone where extractive activities are prohibited to allow natural processes to occur uninterrupted.

The ecological risk assessment for the St. Anns Bank AOI was intended to help determine activities to be permitted or prohibited in the future MPA by identifying the risk posed by each activity to the conservation priorities for the site. The findings from this assessment serve to

highlight activities and interactions that may require careful management and monitoring post MPA designation.

Because this assessment was conducted with an MPA as its focus, tolerance for impacts was lower than it might be for areas outside of the MPA. As such, the risk scores presented here do not necessarily represent DFO's assessment of risks for the same activities elsewhere in the Scotian Shelf bioregion.

1.4 Spatial and Temporal Scope of the Assessment

The geographic extent of the St. Anns Bank risk assessment was defined by the AOI boundary (Figure 1.1-1). Although the consultation process resulted in boundary modifications that included some expansion to the east of the study site, adjacent areas have similar activities with similar ecosystem interactions. As such, the findings reported here will be used to support decision-making for the final St. Anns Bank MPA boundary and zone configuration, including portions of the site that do not fall within the original AOI boundary.

In accordance with DFO Science advice (DFO, 2012c), activities were considered in the assessment if they currently occur within the AOI or if there has been a demonstrated interest in the pursuit of these activities in the near future (*e.g.*, within the next decade).

1.5 Methods

The general risk assessment approach for the St. Anns Bank AOI was designed with flexibility to accommodate varying levels of data availability and to address a wide range of interactions (DFO, 2012d). In general, the data availability and assessment approach varied by socio-economic sector for this study. Thus, for ease of comprehension, the risk assessment has been divided into three separate sections to address each of the three sectors under investigation: Fisheries (Section 2.0), Oil and Gas (Section 3.0), and Marine Transportation (Section 3.0). While common aspects of the risk assessment method are explained here, further sector-specific methodological details are provided at the beginning of these subsequent sections.

1.5.1 Scoping

In general, the first step of ecological risk assessment is scoping (Fletcher, 2005; Hobday et al., 2011; DFO, 2012b), which involves determining the activities and ecosystem components that will be included in the assessment. The scoping of conservation priorities and human activities to be considered in the St. Anns Bank assessment was done through ecological and socio-economic overviews of St. Anns Bank (Ford and Serdynska, 2013; DFO, 2012c), and the preliminary lists were reviewed and revised at a DFO Science Regional Advisory Process in January 2012 (DFO, 2012c). The resulting conservation priorities and human activities considered in this risk assessment are described below.

Conservation Priorities

The primary goal of the proposed St. Anns Bank MPA is to protect and conserve the biodiversity, ecosystem function, and the special natural features of the site. Thus, the MPA is intended to protect the entire St. Anns Bank ecosystem, including the full range of biodiversity

(communities, habitats, species, and populations) and the physical, chemical, biological and ecological processes that comprise it. The ultimate state to be achieved in the MPA is one where ecosystem structure and function is governed by natural processes. However, the ecosystems of the St. Anns Bank area are not well-understood and have not been delineated.

To address this challenge, a list of conservation priorities were recommended by DFO Science based on current available knowledge for the site (DFO, 2012c; Ford and Serdynska, 2013). The conservation objectives for St. Anns Bank MPA were developed based on these priorities, and focus on components of the ecosystem for which reliable information exists – physical features, habitats, and certain priority species and species groupings. The conservation objectives for the MPA are:

Habitat

Protect and conserve:

- Examples of all major benthic, demersal and pelagic habitats within the St. Anns Bank MPA, along with their associated physical, chemical, geological and biological properties and processes;
- Distinctive physical features and their associated ecological characteristics; and
- The structural habitat provided by sea pen and sponge concentrations.

Biodiversity

Protect and conserve biodiversity at the community, species, population and genetic levels within the St. Anns Bank MPA, including, but not limited to:

- Priority species[2] and their habitats; and
- The identified area of high fish diversity.

Productivity

Protect and conserve biological productivity across all trophic levels so that they are able to fulfil their ecological role in the ecosystems of the St. Anns Bank MPA.

The conservation priorities recommended by DFO Science (DFO, 2012c) are more explicit than the broader conservation objectives developed for the site. As such, these priorities were used to assess ecological risks from human activities within the St. Anns Bank AOI, as follows (see below for detailed descriptions of each priority):

Habitat
  Benthic habitats
  Inshore bank habitats
  Shelf habitats
  Slope/channel habitats

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[2] Priority species include those that were identified as Conservation Priorities at the Regional Science Advisory Process meeting in January 2012 (DFO, 2012c).

- Sensitive benthic / structure forming species
  - Sponge
  - Sea pens
  - Coral
- Biodiversity
  - Area of high fish diversity
  - Depleted/at risk species
    - Atlantic cod
    - Atlantic wolffish
    - Redfish
    - American plaice
    - Leatherback turtles
- Productivity (functional groups)
  - Primary producers
  - Zooplankton
  - Benthic invertebrates
  - Forage fish (herring and mackerel)
  - Demersal fish (haddock, flounder, white hake, etc…)
  - Top predators (cetaceans, sharks, seabirds)

As a first step in the risk assessment, the spatial extent of those priorities had to be identified within the AOI boundaries. Data from three of DFO's scientific surveys were used to identify the spatial extent of many of the conservation priorities in the AOI: The Research Vessel (RV) Survey, the 4Vn Sentinel Survey, and the Snow Crab Survey. These are described briefly below. For a detailed description of these surveys, including maps of sampling locations within the AOI, refer to Ford and Serdynska (2012).

The Research Vessel Survey

The RV survey of the entire Scotian Shelf has been conducted every summer since 1970. The purpose of this survey is to monitor the distribution and abundance of fish and certain invertebrate species on the Scotian Shelf. This survey uses an IIA bottom trawl for each tow, which is approximately 1.75 nautical miles and takes place between 50 and 400 m in depth. It uses a random stratified design. It is important to note that coverage of the RV survey within the AOI was limited to depths between 42 and 375 m (Ford and Serdynska, 2013). All fish and selected invertebrates (lobster, shrimp, crab, scallop and echinoderms) are identified and the number of individuals and total weight for each species is recorded.

Horsman and Shackell (2009) used data from the RV survey to create important habitat layers for various fish species. They divided the data into four time periods (1970-1977, 1978-1985, 1986-1993, and 1994-2006) based on significant changes in fisheries management and water temperatures. Within each time period, data were interpolated for the Scotian Shelf and ranked from 1-10 according to relative biomass (observed weight per tow). These ranks were then summed for all time periods to map important habitat for each species over the 36-year time series. Important habitat for each species was defined as areas with relative biomass averaging in

the 80th percentile and higher over the four time periods (rank $\geq$ 32 out of a possible 40). More details on the methods can be found in Horsman and Shackell (2009).

For this assessment, the areas defined as important habitat for Atlantic cod, Atlantic wolffish, Redfish, and American plaice were converted to polygons to determine the spatial overlap with the activities assessed in this document.

The 4Vn Sentinel Survey

The 4Vn Sentinel Survey has been conducted by the longline fishing industry since 1994. The survey is conducted for three weeks in June, three weeks in September, six weeks in October/November, and six weeks in April/May. At each survey location five tubs of gear are deployed. Each tub contains 450–500 #12 circle hooks that remain submerged for 3 to 6 hours at a time. This survey is conducted mainly to monitor cod abundance; however other species are caught and the number of individuals and total weight estimate of all species is recorded.

For the current work, data from the 4Vn Sentinel survey (1995-2010) were used to create important habitat layers for Atlantic cod and Atlantic wolffish . Biomass data for these species were interpolated over space and classified into quantiles. The top 20% ($\geq$80th quantiles) of areas where the species was observed was considered important habitat. These areas were converted to polygons to determine the spatial overlap with the activities assessed in this document.

The Snow Crab Survey

The Snow Crab Survey has been conducted since 2004 and samples 400 stations yearly on the Eastern Scotian Shelf to determine the distribution and abundance of snow crab. The survey uses a Bigouden Nephrops trawl with 40 mm mesh and all species that are caught are identified to the lowest taxonomic level possible. The depth of this survey ranges from approximately 50 to 300m, which covers the majority of the shelf and slope habitats within the AOI.

Data from the Snow Crab survey (2004-2010) were used to create important habitat layers for Atlantic cod, Atlantic wolffish, and soft corals. Biomass data for these species were interpolated over space and classified into quantiles. The top 20% ($\geq$80th quantiles) of areas where the species was observed was considered important habitat. These areas were converted to polygons to determine the spatial overlap with the activities assessed in this document.

<u>Habitat</u>

There are three main habitat types within the area: inshore bank, shelf and slope habitats (Figure 1.5.1-1).

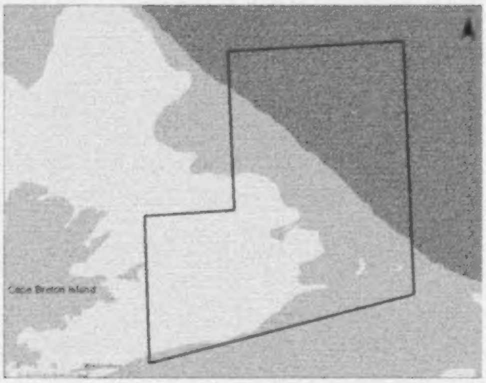

Figure 1.5.1 - 1. The spatial extent of the different habitat types within the St. Anns Bank area of interest (black polygon) including the inshore bank (lightest blue), the shelf (darker blue), and the slope / channel (darkest blue) habitats, modified from Ford and Serdynska (2013).

The habitat classifications were determined by WWF-Canada (2009). The inshore bank habitat includes mainly bedrock with low levels of sedimentation, which is ideal for many species of seaweeds (WWF-Canada, 2009). The shelf habitat is very diverse and ranges from relatively flat bedrock to complex banks, ridges and valleys (WWF-Canada, 2009). The channel habitat within the AOI is steep, with rocky edges and gravel filled furrows (WWF-Canada, 2009). The edges of the channel are important habitat for redfish and flounder species, while the middle of the channel is important for corals and sea pens.

Sensitive benthic / structure forming species

The sensitive benthic / structure forming species conservation priority grouping includes sponges, sea pens, and corals. These species are of particular concern for conservation as they are vulnerable to destruction, damage or removal by bottom-contacting activities (Campbell and Simms, 2009; DFO, 2010b). Both sponges and corals are structure forming, which means they can create habitat for other species in the AOI (DFO, 2012a). Reported locations of these species within and around the AOI are shown in Figure 1.5.1-2. Sponge and sea pen locations were identified through the RV Survey, and significant sponge and sea pen concentrations were identified through a biomass analysis of data collected from the RV survey (Kenchington et al., 2010). The reported location of corals in the area is from the Maritimes Region Coral Database (Cogswell et al., 2009). It is important to note that surveys have not been conducted in the deeper channel waters of the AOI or inshore areas adjacent to Scatarie Island, so the full distribution of these species within the site is not yet fully known. For the purposes of this risk assessment, the spatial extent of sensitive benthic / structure forming species is assumed to be the entire extent of the AOI.

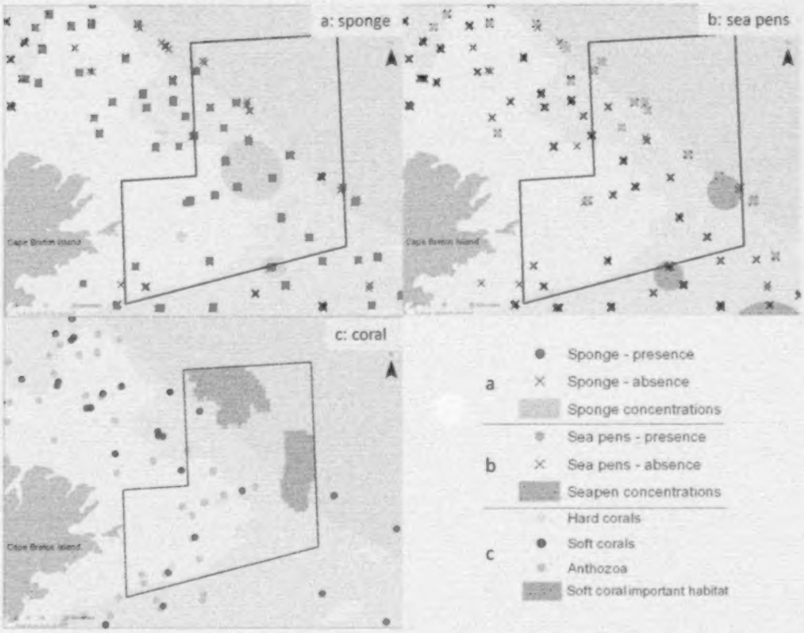

Figure 1.5.1 - 2. Locations of a) sponge presence and absence from the RV survey and the sponge concentrations (modified from Kenchington et al., 2010), b) sea pen presence and absence from the RV survey and the sea pen concentrations (Kenchington et al., 2010), c) different coral types within and around the AOI, taken from the Maritimes Region Coral Database and the soft coral important habitat identified using snow crab survey data.

Biodiversity

Area of high fish diversity

Areas on the Eastern Scotian Shelf that contained high fish diversity were calculated based on RV survey data. Survey sets were assigned to a grid cell, and each unique fish species within the grid cells were counted. A hotspot analysis tool in ArcGIS was used to calculate the areas of high fish diversity, and one of the areas was found to be within the St. Anns Bank AOI (Figure 1.5.1-3; for more information, see Ford and Serdynska, 2013).

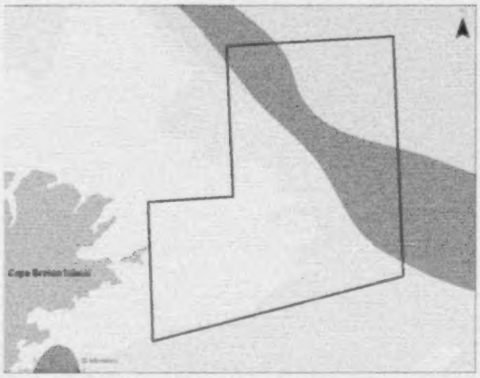

Figure 1.5.1 - 3. The spatial extent of the area of high fish diversity (red polygon) that overlaps with the St. Anns Bank AOI (black polygon), modified from Ford and Serdynska (2013).

Depleted species

Atlantic cod

Atlantic cod (*Gadus morhua*), hereafter referred to as cod, were heavily fished in the latter half of the 20th century and are now listed as endangered under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Government of Canada, 2012). Important habitat for Atlantic cod within the St. Anns Bank AOI was identified through several scientific surveys, including the RV survey (Horsman and Shackell, 2009) and the sentinel survey (Figure 1.5.1-4).

Figure 1.5.1 - 4. Important Atlantic cod habitat in and around the St. Anns Bank AOI (black polygon), identified using the RV survey (pink; Horsman and Shackell, 2009) and the sentinel survey (blue).

Cod found in the St. Anns Bank area can be from three stocks depending on the season. There is a resident stock that remains in the area (i.e., the Northwest Atlantic Fisheries Organization [NAFO] division 4Vn) year round, and two migratory stocks, the Southern Gulf of St. Lawrence stock and the Eastern Scotian Shelf stock (Campana et al., 1995). The migratory stocks overwinter in the St. Anns Bank area from November to April (COSEWIC, 2010a). Through surveys and observations, Campana et al. (1995) determined that resident stock spawning occurs

in the Sydney Bight area in May or June. Because the Sydney Bight area is close to the St. Anns Bank AOI, it is likely that any resident cod within the AOI would also be spawning at this time. Cod are able to spawn in a range of water depths, from tens to hundreds of metres (COSEWIC, 2010a). Cod eggs are buoyant and float in the water column and the larval life stage remains within 10-15 meters depth and feeds on plankton for the first few weeks of life before settling in benthic habitats at the juvenile life stage (COSEWIC, 2010a).

Atlantic wolffish

The Atlantic wolffish (*Anarhichas lupus*) is listed as a species of special concern under both *SARA* and COSEWIC (Government of Canada, 2012). St. Anns Bank includes areas identified as important Atlantic wolffish habitat (Figure 1.5.1-5) using data from the RV (Horsman and Shackell, 2009), snow crab and sentinel surveys. Atlantic wolffish abundance calculations from RV survey catches during the period of 1994 – 2006 identified only 0.4% of the Eastern Scotian Shelf as important habitat for wolffish, and approximately 50% of that important habitat was located within the AOI boundaries (Ford and Serdynska, 2013). Atlantic wolffish spawn between late September and early December (Templeman, 1986). They lay their eggs on the sea floor and the male protects the nest until the eggs hatch (COSEWIC, 2000). Wolffish larvae remain close to the seafloor, and do not move far from where they hatched. While the AOI contains habitat favorable for spawning and nesting, it is currently unclear whether these sensitive life stages occur in the area.

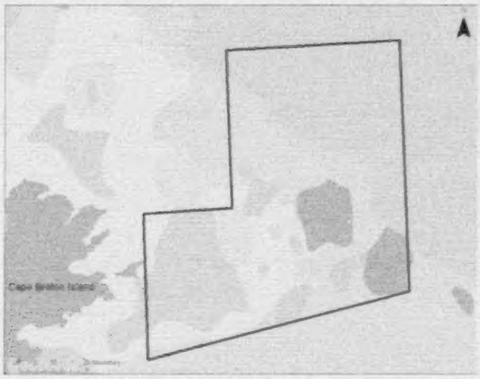

Figure 1.5.1 - 5. Important Atlantic wolffish habitat in and around the St. Anns Bank AOI (black polygon), identified through the RV survey (pink; Horsman and Shackell, 2009), the sentinel survey (blue) and the snow crab survey (green).

Redfish

Redfish are an important commercial fish stock present in the St. Anns Bank area year round (Ford and Serdynska, 2013). Redfish in the area are composed of two species, *Sebastes mentella* and *S. fasciatus*. The Laurentian Channel populations of *S. mentella* have been assessed by COSEWIC as endangered and the Atlantic population of *S. fasciatus* has been listed as threatened (Government of Canada, 2012). Horsman and Shackell (2009) identified important habitat for redfish based on biomass calculations from the RV survey. Within the St. Anns Bank

AOI, the edge of the Laurentian channel was identified as an important area for redfish (Figure 1.5.1-6).

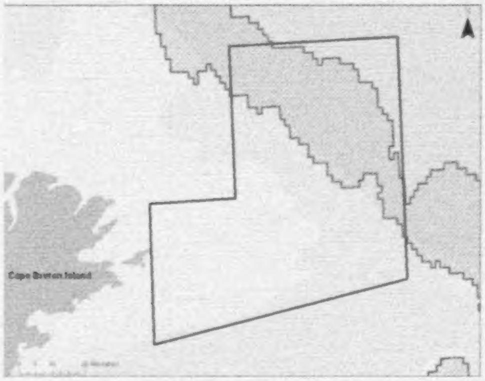

Figure 1.5.1 - 6. Important redfish habitat (hatched red polygon) within the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Both redfish species are found in the Gulf of St Lawrence, the Laurentian Channel, and southern Newfoundland. *S. fasciatus* is generally found in shallower waters (150-300 m), while *S. mentella* is found at depths greater than 300 m. Valentin et al., (2002) suggest that *S. fasciatus* may be more habitat specific, remaining at the same depth and area, whereas *S. mentella* is known to be more pelagic, undertaking horizontal and vertical migrations, as well as annual migrations in and out of the Gulf of St Lawrence.

Unlike most other marine fish, redfish reproduce through internal fertilization as opposed to spawning (COSEWIC, 2010b). Fertilization usually occurs between September and December and the females carry the fertilized eggs until they are released as free swimming larvae into the water column, usually between April and July (DFO, 2012e). Through plankton surveys, the St. Anns Bank area was identified as a historically important area for redfish larval stages (O'Boyle et al., 1984).

American plaice

American plaice (*Hippoglossoides platessoides*) has been over-exploited and is listed as threatened under COSEWIC (Government of Canada, 2012). There are three populations of American plaice in St. Anns Bank area: one resident population, and two migratory populations that come from the Gulf of St Lawrence and Banquereau, respectively (Fowler and Stobo, 2000). American plaice are known to spawn between April and May in nearby Banquereau (COSEWIC, 2009), but it is currently unknown if spawning also occurs within the boundaries of the AOI. Similar to the redfish habitat identification described above, Horsman and Shackell (2009) identified important habitat for American plaice based on biomass calculations from the RV survey (Figure 1.5.1-7).

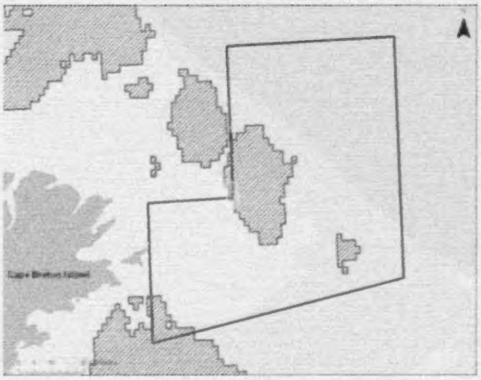

Figure 1.5.1 - 7. Important habitat for American plaice (hatched blue polygon) in and around the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Leatherback sea turtle

The leatherback turtle (*Dermochelys coriacea*) is listed as endangered under *SARA* (Government of Canada, 2012). Leatherbacks are a migratory species that spend winter months in tropical areas on nesting beaches and migrate to temperate waters in the summer months to feed on jellyfish. Most of the St. Anns Bank AOI has been identified as part of important feeding habitat for leatherback turtles (Figure 1.5.1-8). A process is underway to designate this and other areas within Atlantic Canadian waters as critical habitat for this species (DFO, 2012f). The turtles are present and feeding in the area between June and October, with the highest density of individuals occurring in August and September (DFO, 2012f).

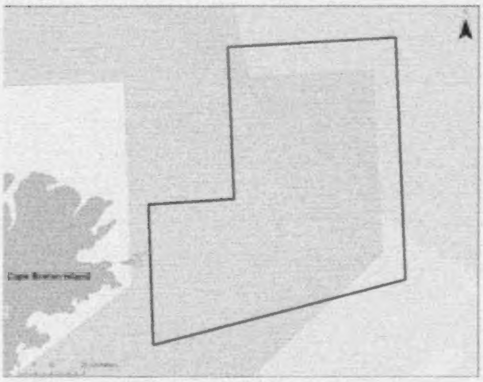

Figure 1.5.1 - 8. Important habitat for leatherback turtles (green polygon; modified from DFO, 2012f) in the St. Anns Bank AOI (black polygon).

<u>Productivity</u>

Primary producers

Diatoms and dinoflagellates are the main components of phytoplankton in the St. Anns Bank area, with large blooms of diatoms occurring in the summer months. The area to the east of Cape

Breton (which includes the area where the AOI is located) has been identified as an area of high chlorophyll levels on the Scotian Shelf (Breeze et al., 2002). For the purposes of this assessment, the spatial distribution of primary producers was assumed to be the entire extent of the AOI.

Zooplankton

The zooplankton in the AOI are seasonal, sinking to depths during the winter months and rising and blooming in surface waters in summer months (Ford and Serdynska, 2013). Over 60% of the biomass of zooplankton in the AOI is composed of three species of copepod (*Calanus* spp.; Head and Harris, 2004). Copepods are important to the ecosystem of St. Anns Bank because they are an important food source for larval and juvenile fish (Ford and Serdynska, 2013). Krill are also found in this area, and provide an important link between phytoplankton and larger species, such as seabirds, whales and redfish. For the purposes of this assessment, the spatial distribution of zooplankton was assumed to be the entire extent of the AOI.

Benthic invertebrates

In addition to the sensitive benthic/structure forming invertebrates mentioned above (i.e., sea pens, sponges, and corals), *Asteroidea* spp. (i.e., starfish) and snow crab are broadly distributed across the site according to data from the RV Survey (Ford and Serdynska, 2013). Other benthic invertebrates found from Snow Crab and RV Surveys in the site include striped shrimp, green sea urchins, sea potato, sea cucumber, lyre crabs and toad crabs in bank habitats, striped shrimp, whelks and sea anemones in shelf habitats, and northern shrimp, stone crab and heart urchins in the slope/channel habitats (Ford and Serdynska, 2013). For the purposes of this assessment, the spatial distribution of benthic invertebrates was assumed to be the entire extent of the AOI.

Forage fish

The forage fish group includes all small fish species that live and feed in the water column. Herring, mackerel, and capelin are important forage fish found within the AOI. These fish provide food for many larger fish, marine mammals and seabirds (Scott and Scott, 1998; DFO, 2005). Several populations of herring can be found in the St. Anns Bank AOI, including a possible resident population and a migrating stock (Ford and Serdynska, 2013). The southern Gulf of St. Lawrence population migrates into the St. Anns Bank area in October, overwinters in the site, and returns to the Gulf between April and July to spawn (LeBlanc et al., 2001). The resident population has been known to spawn in the fall (Stephenson et al., 2009) along the coast of Cape Breton in several known spawning areas; the Red Grounds, Glace Bay, and the Big Shoal (Power et al., 2010). The Big Shoal, which is located within the AOI boundaries (Figure 1.5.1-9), was once an important spawning area according to information provided by local fishers. More research is needed to determine the current importance of the Big Shoal as a herring spawning area (Rabindra Singh, DFO scientist, personal communication). Other areas within the AOI have also been identified by Horsman and Shackell (2009) to be important habitat for herring based on biomass estimates using RV trawl survey data (Figure 1.5.1-10).

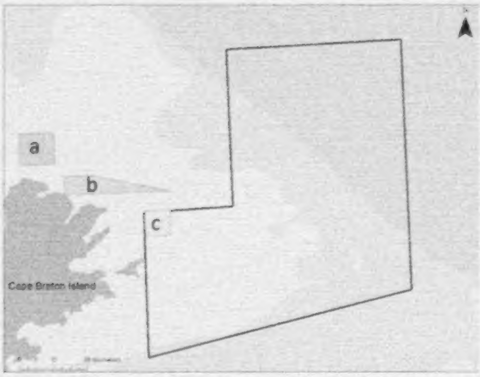

Figure 1.5.1 - 9. The location of a) the Red Ground, b) the Glace Bay Ground and c) the Big Shoal herring spawning areas within and around the St. Anns Bank AOI (black polygon).

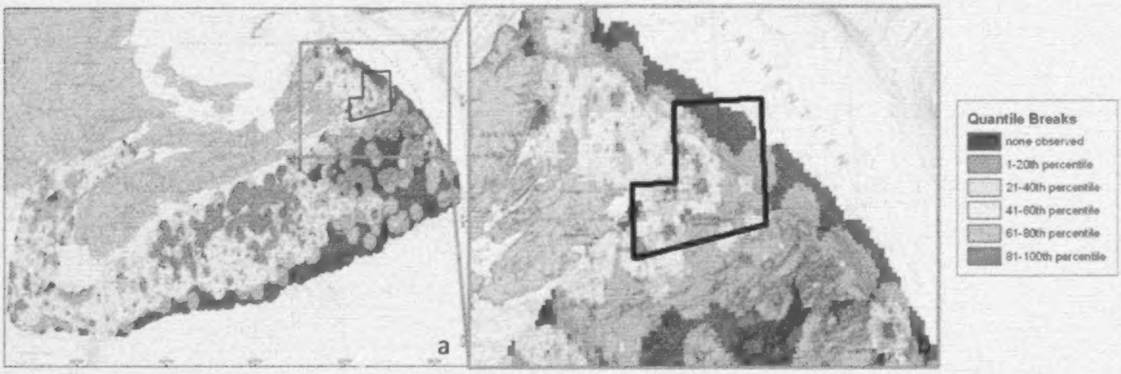

Figure 1.5.1 - 10. Herring distribution on a) the Scotian Shelf and b) within St. Anns Bank AOI (black polygon) based on the RV surveys from 1994-2006 (from Horsman and Shackell, 2009).

Mackerel distribution and abundance is less well known in the AOI, but the area is known to be traversed as part of the annual migration of mackerel moving in (late May to early July) and out (October/November) of the Gulf of St. Lawrence (Ford and Serdynska, 2013). There are no records of mackerel catches in the area since 2002, but available fisheries logbook records report over 23 tonnes of mackerel were caught in the area between 1997-2001.

Capelin have a patchy distribution on the Scotian Shelf depending on the year, but since 1990, results from the RV survey have shown a widespread distribution over the St. Anns Bank area (Ford and Serdynska, 2013; Figure 1.5.1-11). There is no scientific information on the spawning areas of capelin on the Scotian Shelf, but traditional knowledge has reported capelin spawning in coastal areas of the Sydney Bight (Schaefer et al., 2004).

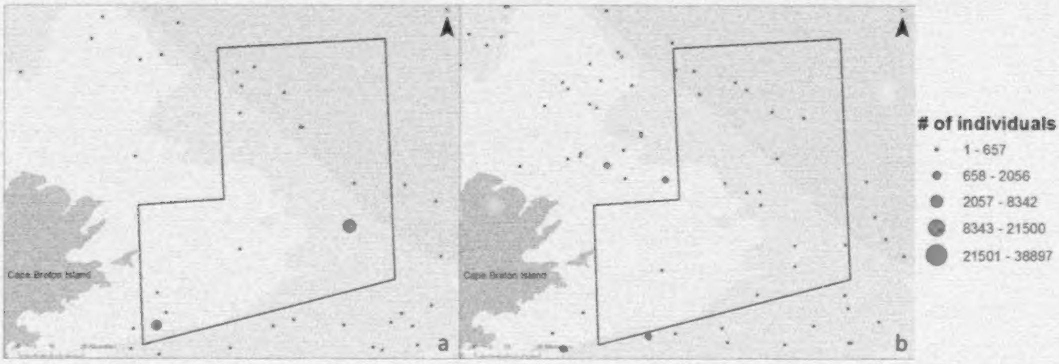

Figure 1.5.1 - 11. Capelin catch in the summer RV survey from a) 1990-1999, and b) 2000-2010 in the St. Anns Bank AOI (black polygon) (from Ford and Serdynska, 2013).

Sand lance is a forage fish species found within the AOI, however, the AOI is not a significantly important area for sand lance on the Scotian Shelf (Ford and Serdynska, 2013). Sand land abundance is hard to determine through traditional survey methods because they burrow into the sand during the day, however plankton tows have suggested that the highest abundance of sand lance is located on the eastern portion of the Scotian Shelf (DFO, 1996). Altogether, for the purposes of the risk assessment forage fish as a group are assumed to have a wide distribution across the entire AOI.

Demersal fish

Demersal fish are those species that live, hunt, and feed on prey on the sea floor. Demersal fish that occur within the St. Anns Bank AOI includes the depleted fish species listed above (i.e., Atlantic wolffish, Atlantic cod, American plaice and redfish), and also haddock, red and white hake, yellowtail, winter and witch flounder, and dogfish. Horsman and Shackell (2009) identified important habitat in St. Anns Bank for witch flounder and white hake based on biomass calculations from data collected from the RV survey (Figure 1.5.1-12).

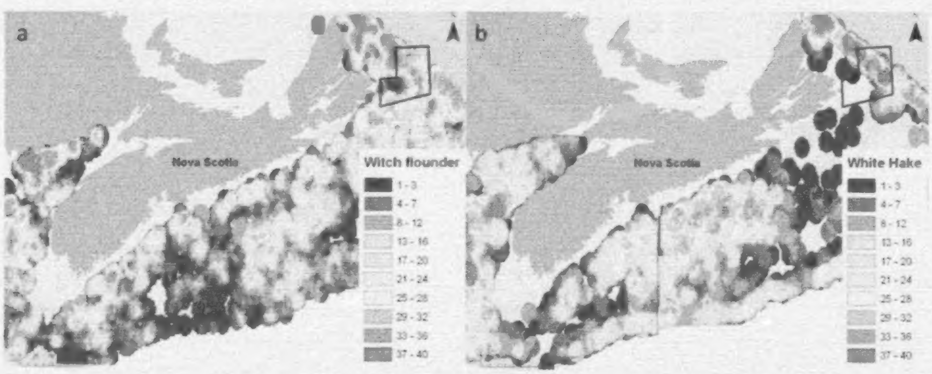

Figure 1.5.1 - 12. The abundance of a) witch flounder and b) white hake on the Scotian shelf, determined by biomass calculations from research trawl survey data (modified from Horsman and Shackell, 2009).

Witch flounder migrates into the St. Anns Bank area to overwinter. Witch flounder on the Scotian Shelf tend to spawn in deeper waters (500-700 m) between May and October, with the peak spawning period occurring in July and August (DFO, 2013a). Larvae and eggs remain in the water column for over four months, drifting over great distances with currents (DFO, 2013a). White hake in the southern Gulf of St. Lawrence spawn between June and September, with the peak spawning time occurring in June. The eggs and larvae are pelagic and remain in the upper layers of the water column for a number of months before settling in benthic habitats (DFO, 2013a). It is unknown if these species spawn within the boundaries of the AOI. However, given that the AOI includes important summer habitat for these species, it is possible that spawning occurs in this area.

The spatial extent of the demersal fish species group within the AOI was determined by combining the spatial extent of important habitat for all demersal fish species in the AOI (i.e., important habitat for witch flounder, white hake, Atlantic cod, Atlantic wolffish, American plaice and redfish; Figure 1.5.1-13). As a result, the majority of the AOI was determined to be important for demersal fish as a functional group.

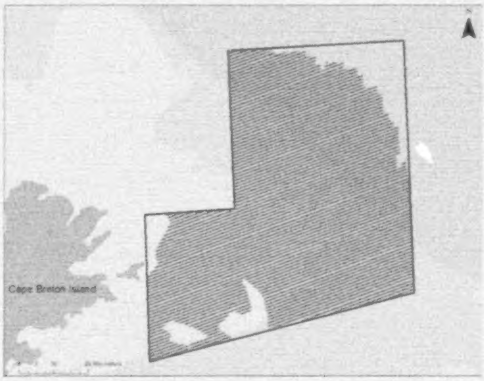

Figure 1.5.1 - 13. Important habitat for the demersal fish group (combined important habitats for Atlantic cod, Atlantic wolffish, American plaice, redfish, witch flounder, and white hake).

Top Predators (Marine mammals, sharks and seabirds)

Marine mammals

While information is limited, the St. Anns Bank AOI is considered part of the migration route for whales travelling the Atlantic Ocean and the Gulf of St. Lawrence (Ford and Serdynska, 2013). Available sightings data and relevant literature suggest the most commonly occurring cetaceans using AOI would be the fin whale (*Balaenoptera physalus*), minke whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*), pilot whale (*Globicephala* spp.), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), and common dolphin (*Delphinus* spp.). Other species that may occasionally be found in the area include the sei whale (*Balaenoptera borealis*), blue whale (*Balaenoptera musculus*), northern right whale (*Eubalaena glacialis*), killer whale (*Orcinus orca*) and the harbor porpoise (*Phocoena phocoena*) (Ford and Serdynska, 2013). Of these species, several are listed under the *Species at Risk Act*, including fin whale

(special concern), blue whale (endangered), North Atlantic right whale (endangered), and harbour porpoise (threatened) (Ford and Serdynska, 2013).

Most of the cetacean species listed above are migratory and would likely be found in the AOI during the period from late spring to early fall. However, there are some species that remain in north Atlantic waters and may be found in the AOI year round. For example, while minke and humpback whales are most likely to be found within the AOI during the summer months, individuals of these species are known to remain in waters off Nova Scotia in winter and so may be found in the AOI throughout the year (Ford and Serdynska, 2013). Pilot whales are common in nearshore waters off Cape Breton during the summer months (Breeze et al., 2002) but are also year round residents of the Laurentian Channel (Templemen et al., 2010). As such, it is likely that pilot whales may be found in the AOI throughout the year (Ford and Serdynska, 2013).

The seal species that are most likely to occur within the AOI are the grey seal (*Halichoerus grypus*), the harp seal (*Pagophilus groenlandica*) and the harbour seal (*Phoca vitulina*). The grey seal is the most common species of seal that would use the AOI, and Scatarie Island is a pupping area for this species (Doherty and Horsman, 2007). Grey seals spend time in and around the AOI during the first half of the year as part of their seasonal migration to and from the Gulf of St Lawrence (Ford and Serdynska, 2013). Harbour and harp seals are likely to use the AOI as a migration route and for foraging. Harp seals will also pup in the area between March and April in years with significant ice cover (Ford and Serdynska, 2013).

Sharks

Shark species that occur within the AOI include porbeagle sharks (*Lamna nasus*), blue sharks (*Prionace glauca*), basking sharks (*Cetorhinus maximus*), and shortfin mako sharks (*Isurus oxyrinchus*). Porbeagle sharks are the most common shark species in the AOI, and the area includes a portion of the mating grounds for this species (Ford and Serdynska, 2013). The porbeagle shark is listed as endangered under COSEWIC while blue and basking sharks are listed as species of special concern and the short fin mako shark is listed as threatened.

Seabirds

There are many seabird species that either nest near or migrate through the AOI. Species that can be found in the AOI in large numbers include storm-petrels (Hydrobatidae), great black-backed gulls (*Larus marinus*), herring gulls (*Larus* spp.), northern fulmars (*Fulmarus glacialis*), great shearwaters (*Puffinus gravis*), sooty shearwaters (*Puffinus griseus*), and northern gannets (*Morus bassanus*). While gulls and storm-petrels may be nesting or foraging in the area, most other species are found in large numbers in the AOI during migration. Other species that nest on and near Scatarie Island include the common eider (*Somateria mollissima*), double-crested cormorants (*Phalacrocorax auritus*), great cormorants (*Phalacrocorax carbo*), black guillemot (*Cepphus grylle*), common tern (*Sterna hirundo*), Arctic tern (*Sterna paradisaea*), leach's storm-petrel (*Oceanodroma leucorhoa*) and black-legged kittiwake (*Rissa tridactyla*).

Human Activities

In accordance with advice provided by DFO (2012c), the St. Anns Bank risk assessment focuses on risks to the conservation priorities from human activities that are already taking place within

the AOI (i.e., fisheries and marine transportation) and also risks from certain new activities that have been contemplated for the near future (i.e., oil and gas exploration). The following human activities will be considered as part of the St. Anns Bank risk assessment:

Fishing
- Snow crab pot
- Lobster pot
- Groundfish otter trawl (primarily for redfish)
- Groundfish midwater trawl (primarily for redfish)
- Halibut bottom longline
- Herring or mackerel gillnet
- Whelk pot
- Hagfish pot
- Seal harvest

Oil and Gas Exploration
- Seismic
- Exploratory drilling

Marine Transportation
- Vessel Transit
- Small Oil Spills
- Large Accidental Spills
- Ballast Water Exchange

Each of these activities will be further described as part of the introduction to the sector-specific risk assessments (see Sections 2.0-4.0).

Activities that will not be considered in the St. Anns Bank AOI ecological risk assessment include land-based pressures, and activities that have either never occurred in the area (e.g. seabed mining, offshore aquaculture, renewable energy generation, etc.), or are not currently being planned for the area (e.g., submarine cable laying or petroleum production). Fisheries that have not been conducted in the AOI since 1991 (based on available logbook data) will also not be considered in the assessment. In addition, some sporadically occurring fisheries (listed below) will not be considered. Instead, the detailed assessments of more common fisheries will be used to support decision-making for other similar fisheries. For example, the lobster pot assessment could be used to inform decisions about the rock crab fishery, which uses very similar gear and is carried out in a similar area (Squires and Gromack, 2013).

Sporadic or historic fisheries not being assessed:
- Herring/ mackerel handline
- Herring purse seine
- Groundfish (Danish/Scottish) seine
- Otter trawl for groundfish other than redfish (*e.g.* Atlantic cod)
- Scallop dredge
- Shark longline
- Shrimp trawl
- Rock crab pots
- Recreational trolling

Other low-impact activities, such as research, monitoring and tourism, will be evaluated on a case-by-case basis through an activity application after the MPA is designated.

1.5.2 Potential for Interaction

Once the activities and ecosystem components to be considered in the assessment have been identified, the next step in the risk assessment process is to evaluate the potential for interaction to determine which interactions merit analysis. For the St. Anns Bank risk assessment, the potential for interaction was determined based on expert opinion. For example, in St. Anns Bank, vessels transiting through the site might interact with turtles or cetaceans, but would not be expected to physically interact with benthic habitats. As such, the risk assessment for the Marine Transportation sector (Section 4.0) included an analysis of the impacts of vessel transits on turtles and cetaceans (i.e., top predators), while risks to sponge and sea pen concentrations were not assessed. The potential for interaction between each activity and the conservation priorities was evaluated as part of each sector-specific assessment (see Sections 2.0 – 4.0). For each activity, a risk assessment was conducted for only those conservation priorities where a potential interaction exists.

1.5.3 Analysis

The next step of the St. Anns Bank risk assessment process was the analysis. This is where the likelihood and consequence of an event (i.e., human activity) on a given objective (i.e., conservation priority) are assessed using the best available information and then combined to determine a level of risk for the interaction (ISO, 2009). In accordance with the ISO (2009), the analysis process should take into account any controls or mitigation efforts already in place, and should identify any factors that might affect the consequences or likelihood, including the level of uncertainty associated with the conclusions.

For the St. Anns Bank risk assessment, likelihood was defined as the percentage of spatial overlap between the activity to be assessed and the spatial extent or distribution of each conservation priority (i.e., the percentage of the conservation priority area within the AOI where the activity under investigation occurs). For many of the conservation priorities and human activities, there is limited or generalized information on the spatial distribution, resulting in either an over or underestimate of the degree of overlap. It is also important to note that this spatial approach to analyzing likelihood does not allow for the consideration of the probability of an event occurring. Therefore, the assessment was conducted based on the worst case scenario (i.e., risk was determined based on the assumption that the event would occur). For cases where the probability of an interaction was low (e.g., large oil spill due to a shipping-related accident), this caveat to the assessment was acknowledged.

Consequence was generally defined as the impact of an interaction, with consideration for the potential for long-term harm and the capacity for resistance and/or recovery from exposure. For most species/species groups, consequence levels were determined based on impacts to the local population. For at-risk and depleted species, consequences of interactions were generally considered to be more severe because adverse impacts have more potential to affect the population. Wherever relevant, consequence level determinations were driven by considerations

for impacts on the most vulnerable species under consideration (see "plausible worst case" approach described in Hobday et al., 2011).

Both likelihood and consequence were measured in relative terms (e.g., low, medium or high). Once the likelihood and consequence of an interaction was determined, a risk matrix was used to estimate the level of risk of the interaction (see Table 1.5.3-1 for example). To use the risk matrix, consequence (y-axis) and likelihood (x-axis) scores are assigned to an interaction, and the resultant risk score is the intersection between the two axes. For example, using the generic risk matrix shown in Table 1.5.3-1, if an interaction is determined to have a medium level of consequence but a high level of likelihood, the overall risk score would be considered high.

Table 1.5.3 - 1. Example risk matrix used to evaluate risk for each interaction in the St. Anns Bank risk assessment.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

1.5.4 Uncertainty and Precaution

Risk assessment often includes a considerable level of uncertainty due to limitations in data quality, and/or the requirement to make assumptions as part of the risk scoring exercise (IS0, 2009). Because of this, it is important to include an evaluation of the quality of available information to communicate a level of confidence with the assigned risk score. For the St. Anns Bank assessment, risk scores were assigned a relative level of uncertainty based on information quality criteria provided by DFO Science (DFO, 2012c; see Table 1.5.4-1).

Table 1.5.4 - 1. Definitions of relative uncertainty levels used in the St. Anns Bank risk assessment (adapted from DFO, 2012c).

Level	Definition
Very low certainty	No relevant data could be found.
Low certainty	Limited data from the area or data only from other areas/ similar pressures, and poorly understood in those contexts.
Moderate certainty	Data from other areas or similar pressures, but well understood in those contexts OR moderate amount of data from this area and pressure.
High certainty	Good data based on the area and pressure.

The risk assessment for St. Anns Bank was also conducted with consideration for the precautionary principle. This means that the evaluator erred on the side of caution when assigning consequence and likelihood scores for cases where uncertainty was high.

2.0 COMMERCIAL FISHING

2.1 Sector Overview

There are a number of commercial fisheries that use the St. Anns Bank area as fishing grounds. The impacts from fishing activity can range from minimal to very destructive depending on the nature of the fishery and the type of gear that is used. For example, pelagic gears may not impact benthic communities but may pose entanglement risk to marine mammals and turtles. Likewise, fixed bottom-contacting gears (e.g., snow crab pots) damage the benthos less than mobile bottom-contacting gears (trawls). Some gear types (e.g., hagfish pots) may be very selective for the directed species while others (e.g., demersal longline) may catch a variety of bycatch species along with the targeted species.

In general, total landings from fisheries in the St. Anns Bank area have been in decline since 2000 (for a detailed overview of fishing activities in the area, see DFO, 2012d). The number of licence holders and vessels that actively fish in the area have also decreased over the past decade. Currently, the two largest fisheries (as indicated by landed value) are the snow crab and groundfish (halibut and redfish) fisheries.

Existing Mitigation

Commercial fisheries are managed by DFO in accordance with subsection 7(1) of the *Fisheries Act* through Integrated Fisheries Management Plans, variation orders, regulations, and licence conditions. Mitigation measures used to reduce ecological impacts from fishing activities may include seasonal and area restrictions, quotas, incidental catch (i.e., bycatch) restrictions, gear specifications, and monitoring (e.g., At-sea observers, dockside monitoring, vessel monitoring system) and reporting (e.g., hail out/in, logbook records) requirements.

Strategies used across the Department to address bycatch in fisheries are outlined in the Guidance on Implementation of the Policy on Managing Bycatch[3]. Some important general measures include the mandatory release of most species other than the target species in a manner that causes the least amount of harm (Section 33 of the *Fishery General Regulations*). In the groundfish fisheries, all groundfish caught must be retained (i.e., not discarded) with some exceptions (e.g., northern wolffish, spotted wolffish, and thorny skate; see Section 93.3 of the *Atlantic Fishery Regulations*, 1985). There are also limits on total catch of Atlantic wolffish, Redfish, American Plaice, Atlantic cod and undersized fish that are allowed to be caught as bycatch.

Entanglement in fishing gear has been identified as an issue for the SARA-listed leatherback turtle and several SARA-listed whale species. In some fisheries (e.g. pelagic longline), licence conditions require that fishers are trained how to dis-entangle turtles and whales and report any interactions with SARA-listed species (mainly marine mammals and turtles) by submitting a SARA logbook report. Recovery strategies for SARA-listed marine mammals and turtles also

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[3] http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/bycatch-guide-prise-access-eng.htm

include commitments to research methods of reducing entanglements, provide education and tools for dis-entanglement, and promote reporting of interactions through SARA logbooks.

2.2 Scope of the Commercial Fishing Risk Assessment

The fisheries that underwent assessment include those that are currently occurring and several others that may occur in the near future (as indicated by expressions of interest from the fishing industry) within the boundaries of the AOI. These are: pot/trap fisheries for snow crab, lobster, whelk, and hagfish, the otter trawl and midwater trawl fisheries for redfish, the bottom longline fishery for halibut, the gillnet fishery for herring and mackerel, and the seal harvest.

2.3 Methods

Sources of information

In general, the likelihood scores for the risk assessment were calculated using data from fisheries logbooks reported between 1995 and 2010. These data include catch locations, dates, and weights of landed species. The main source of information for determining bycatch-related consequence scores for each fishery was the At-Sea Observer program database. This database contains information reported by trained fisheries observers that monitor at-sea fishing activities on varying percentage of randomly selected fishing vessels. Catch information collected by Observers includes locations, dates, and weights of all species caught (i.e., including targeted species, bycatch species, and discarded species). For the St. Anns Bank Assessment, At-Sea Observer data reported within the Northwest Atlantic Fisheries Organization (NAFO) division 4Vn, which encompasses the St. Anns Bank AOI, was used to determine fishery-specific bycatch levels for the area. Because there was no available data in the observer database for the inshore lobster fishery in the St. Anns Bank area, bycatch levels for this fishery were determined with reference to a study by den Heyer et al., (2010), which provides bycatch estimates for the local lobster fishery using experimental traps. Consequences for conservation priorities that may not be adequately represented in the observer database (e.g., benthic habitats, leatherback turtles, marine mammals) were determined through literature review or through expert opinion.

Potential for Interaction

The potential for interactions between each of the commercial fisheries and the conservation priorities are identified in Table 2.3-1. Briefly, bottom-contacting gears (*i.e.*, pots, otter trawl, and bottom longline) were considered to have the potential to interact with conservation priorities associated with the benthos as well as turtles and top predators due to the possibility of entanglement. Gear types that were not expected to contact the bottom (*i.e.*, gillnets) would not be expected to interact with strictly benthic organisms, but may interact with fish, turtles and top predators. The seal harvest would not interact with any conservation priorities other than the top predators group. Fisheries interactions with primary producers and zooplankton were not considered relevant for assessment.

Table 2.3 - 1. Potential for interaction between commercial fishing activities and conservation priorities for the St. Anns Bank AOI. Dark blue shading indicates a known potential for interaction, light blue indicates an interaction may exist and white indicates no interaction is expected.

Conservation Priority	Snow crab pot fishery	Lobster pot fishery	Groundfish otter trawl	Groundfish midwater trawl	Halibut bottom longline	Herring roe gillnet fishery	Gillnet bait fishery	Whelk pot fishery	Hagfish pot fishery	Seal harvest
Habitat										
Benthic habitats										
Sensitive benthic/ structure forming species										
Biodiversity										
High fish diversity										
Atlantic cod										
Atlantic wolffish										
Redfish										
American plaice										
Leatherback turtles										
Productivity										
Primary producers										
Zooplankton										
Benthic invertebrates										
Forage fish										
Demersal fish										
Top predators										

Likelihood levels

Where data permitted, the spatial footprint of each fishery was determined by mapping the number of sets per 2x2 minute grid cell (~10 km^2) within the AOI. For the purposes of this analysis, a 'set' was defined as a fishing logbook entry that includes information for all species caught within a reporting interval assigned to a single geographic location (catch locations are generally rounded off to the nearest minute). Depending on the fishery, a set might be a summary of fishing activity for a full day, for a single gear deployment/retrieval, or for another reporting interval. Unless otherwise specified, grid cells where more than one set was reported between 1995 and 2010 were considered part of the fishing footprint for each fishery. Given the limitations in data resolution (i.e., geographic accuracy and reporting frequency), this approach to determining the spatial extent of each fishery should be considered an approximation only. To determine the potential footprint of proposed fisheries with limited or no commercial harvest data available for the area, expert opinion and/or identified areas of interest were used.

The likelihood of an interaction occurring between each fishery and the conservation priorities in the St. Anns Bank AOI was based on the percentage of overlap between the known (or proposed/ predicted) footprint of the fishery and the spatial extent of each conservation priority (Table 2.3-2).

Table 2.3 - 2. Likelihood definitions for the commercial fisheries risk assessment for the St. Anns Bank AOI.

Likelihood level (% overlap)	Likelihood definition
Very low	<1% of the conservation priority area overlaps with the fishing area
Low	<10% of the conservation priority area overlaps with the fishing area
Medium	10-50% of the conservation priority area overlaps with the fishing area
High	> 50% of the conservation priority area overlaps with the fishing area

Consequence levels

Consequence definitions in this assessment vary by activity, conservation priority and available data. The definitions of consequence for benthic habitats (Table 2.3-3) were determined based on considerations of impacts by gear type (DFO, 2006, and DFO, 2012a) on areas with varying levels of natural disturbance (Ford and Serdynska, 2013; Figure 2.3-1). The levels of natural disturbance were originally developed by Kostylev and Hannah (2007) by calculating the ratio of velocity to stress and conducting a log transformation on the ratio. See Ford and Serdynska (2013) for a further description of the natural disturbance levels.

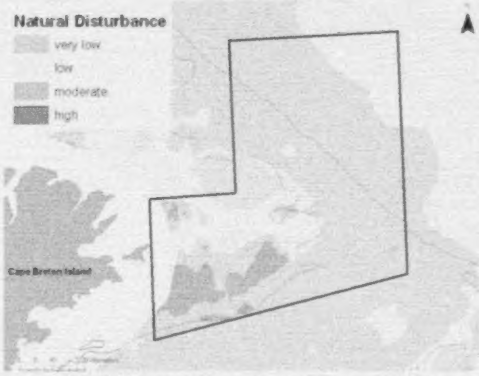

Figure 2.3 - 1. The levels of natural disturbance in benthic habitats within and around the St. Anns Bank AOI (adapted from Ford and Serdynska 2013).

The consequence definitions for sensitive benthic / structure forming species, leatherback turtles and marine mammals were determined based on the expectation for impacts (e.g., disturbance, entanglement) as suggested by the relevant literature (Table 2.3-3).

Where observer data were available, the percent of sets that included species relevant to the conservation priority under assessment was used to define the level of consequence. Bycatch tolerance levels for depleted species were set to be considerably lower than for non-depleted species (i.e., a high consequence score for a fishery's impact on depleted species required just 5% of sets containing the depleted species, while for non-depleted species a high consequence score was assigned if bycatch levels were higher than 50%; Table 2.3-3).

Because observer data were not available for the inshore lobster fishery, a study by den Heyer et al., (2010) provided the bycatch estimates for the lobster fishery in the St. Anns Bank AOI. Using the available data from this work, consequence levels for the lobster fishery were defined as various percentages of the catch, which was calculated from the number of individuals of a species relevant to the conservation priority reported to be caught in 900 experimental lobster traps deployed between May 16th and July 15th, 2006 (Table 2.3-3). Only a small portion of the landings in the Lobster Fishing Area encompassing the St. Anns Bank AOI were sampled during this study, so the available bycatch profile may not be entirely representative. As such, the level of certainty associated with consequence score assignments based on these data was considered to be low.

This assessment focused on the nature and distribution of activities and ecological features within the AOI boundaries, taking into account the conservation objectives for the proposed MPA. The consequence scores for fisheries as determined through this exercise do not necessarily represent DFO's assessment of consequences for the same activities elsewhere in the Scotian Shelf bioregion.

Table 2.3 - 3. Consequence definitions for fisheries risk assessment for the St. Anns Bank AOI.

Consequence level	Benthic habitats	Sensitive benthic / structure forming species / benthic inverts susceptible to crushing	Leatherback turtles and marine mammals	Depleted / at risk fish	Non-depleted fish species and benthic invertebrates susceptible to bycatch
Very low	Gear has little or no contact with the benthos	Gear-associated entanglement and/or damage is not known to occur	No evidence to suggest entanglement/harm is a risk for the fishery	Species not detected in observer sets* / catch**	Species not detected in observer sets/catch
Low	Bottom fixed gear in areas of moderate to high natural disturbance	Gear-associated entanglement and/or damage may occur on rare occasions	Potential for entanglement/harm identified in literature, but very few or no documented cases in the northwest Atlantic	Species found in 0-1% of sets/catch	Species found in 0-25% of sets/catch
Medium	25% or more of bottom fixed-gear fishery overlaps with areas with very low to low levels of natural disturbance <u>or</u> bottom mobile gear fishery occurring in areas of moderate to high levels of natural disturbance	Gear-associated entanglement and/or damage may occur under certain conditions (e.g., tides/currents)	Potential for entanglement/harm identified; occasional occurrences in the northwest Atlantic	Species found in 1-5% of sets/catch	Species found in 25-50% of sets/catch
High	25% or more of bottom mobile-gear fishery overlaps with areas of very low to low levels of natural disturbance	Gear-associated entanglement and/or damage is common to the fishery	Potential for entanglement/harm identified; occurrences are frequent in the northwest Atlantic	Species found in more than 5% of sets/catch	Species found in more than 50% of sets/catch

* % of set refers to the percent of observed data sets that contained one or more individuals of a species relevant to the conservation priority under assessment.

** % of catch was calculated from the number of individuals of a species relevant to the conservation priority caught in 900 experimental lobster traps, as reported in den Heyer et al., (2010).

2.4 Risk Assessment for Commercial Fisheries in the St. Anns Bank AOI

2.4.1 Snow Crab Pot Fishery

Snow crab supports the second most valuable fishery in Atlantic Canada and the third most valuable in Nova Scotia, with catches on the Eastern Scotian Shelf having increased from about 1750 mt in 1997 to a peak of 11,428 mt in 2009 (Choi and Zisserson, 2011). The fishery is open in the area from April 17th to August 19th each year and is conducted with baited conical traps. Only mature, male snow crabs are retained and very low bycatch is observed (Choi and Zisserson, 2011).

The snow crab pot fishery in the St. Anns Bank AOI is managed in two units, the northeastern Nova Scotia unit, which includes most of the AOI area, and the southeastern Nova Scotia unit, which is the area of the AOI that is roughly south of Scatarie Island (Choi and Zisserson, 2011). The fishing season in the northern management unit is from mid-April to mid-May and from mid-July to the end of August, and the season in the southern management unit is from April through September. Snow crab landings from within the boundaries of the AOI were highest from 2001 to 2004 and have dropped in recent years (DFO, 2012d). Between 2000 and 2009 the catch from the AOI accounted for 0-1.5% of the catch in the northern management area and 0-1.5% of all landings in the southern management area (DFO, 2012d). The total landings within the boundaries of the AOI are shown in Table 2.4.1-1.

Table 2.4.1 - 1. Total snow crab landings in metric tonnes (mt), from within the AOI boundaries.

Year	Landings (mt)
2000	20.32
2001	105.18
2002	126.40
2003	140.72
2004	131.62
2005	7.33
2006*	
2007*	
2008	10.25
2009	20.81
2010**	27.49

* Landings values for 2006 and 2007 were limited, and so could not be included to protect confidentiality.
** Data were considered preliminary when the review was performed

The spatial extent of the snow crab fishery in the AOI was determined by the number of fishing sets as reported in fisheries logbooks from 1995-2011. Specifically, set locations were summed within 2x2 minute grid cells (~10 km^2) and cells containing two or more sets were used to define the spatial extent of the snow crab fishery in the AOI (Figure 2.4.1-1).

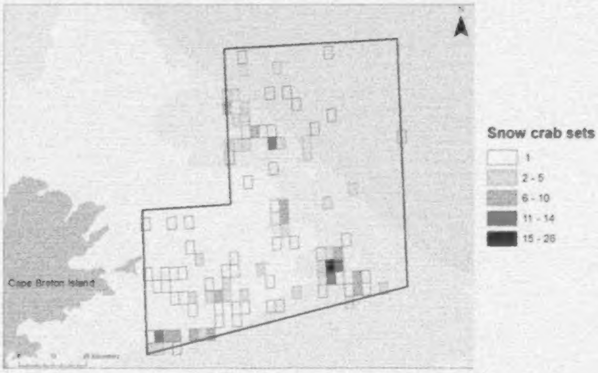

Figure 2.4.1 - 1. The total fishing extent (sum of all colored grid cells) for the snow crab fishery between 1995 and 2011 within the AOI was 468 km^2. Grid cells containing only one recorded set were not included as part of the fishing footprint.

Between 1995 and 2011, a total of 1828 snow crab fishing sets were monitored as part of the At-Sea Observer program within 4Vn (Table 2.4.1-2). As reported in the annual snow crab assessment, the proportion of sets containing other species was very small, and the most commonly caught bycatch species were sea stars and other crabs (Choi and Zisserson, 2011). While some groundfish were also caught, these species were present in less than one percent of sets (Table 2.4.1-2).

Table 2.4.1 - 2. Species caught in the snow crab fishery based on observer data from 1995-2011 within 4Vn.

Species	# of sets	% of sets
Snow crab (Queen)	1828	100
Asteroidea S.C. (sea stars)	17	0.93
Toad crab unidentified	12	0.66
Toad crab	11	0.60
Northern stone crab	10	0.55
Cod (Atlantic)	4	0.22
Witch flounder	3	0.16
American plaice	2	0.11
Jellyfishes	2	0.11
Atlantic wolffish	2	0.11
Eelpout	1	0.05
Hermit crabs	1	0.05
Leatherback sea turtle	1	0.05
Sea cucumbers	1	0.05
Sea urchins	1	0.05
Snails and slugs	1	0.05
Spotted wolffish	1	0.05
Turbot (Greenland halibut)	1	0.05
All fish species	12	0.66
Benthic invertebrates (other than snow crab)	46	2.52
Demersal fish (non-depleted)	6	0.33

Risk presented by the Snow Crab Pot Fishery to Conservation Priorities

a. Benthic habitats

The spatial extent of the snow crab pot fishery occurs mainly in the shelf and inshore bank areas, and covers less than 10% of the AOI (Figure 2.4.1-1), resulting in a low likelihood score. Snow crab pots are a fixed benthic gear and the activity mostly takes place in areas of moderate to high levels of natural disturbance (Figure 2.4.1-2), which resulted in a low consequence score and an overall **low** risk from the snow crab pot fishery to benthic habitats in the AOI (Table 2.4.1-3). There was a moderate level of certainty associated with this assessment based on available data on fishing activity in the area and the available literature on impacts of bottom fixed fishing gear on benthic habitats.

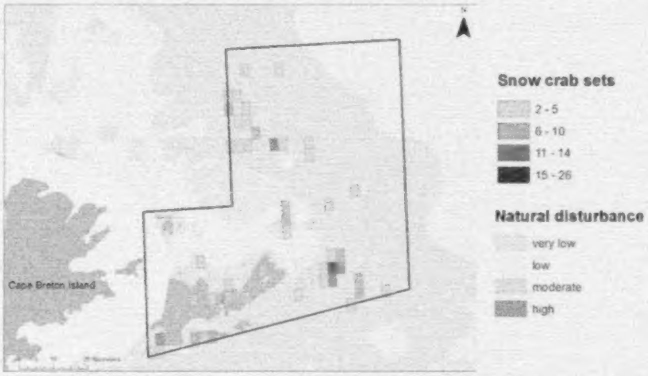

Figure 2.4.1 - 2. The spatial overlap between the snow crab fishery and the levels of natural disturbance (modified from Ford and Serdynska, 2013) for benthic habitats in the St. Anns Bank AOI (black polygon).

Table 2.4.1 - 3. Risk of the snow crab fishery to benthic habitats in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Sensitive benthic / structure forming species

Sponges, sea pens and corals are widely distributed across the site. The snow crab fishery overlaps with less than 10% of the AOI (Figure 2.4.1-3), and only a small portion of the fishing footprint occurs in areas identified as important habitat for sensitive benthic species. Therefore, the likelihood of an interaction with sensitive benthic and structure forming species was determined to be low. Trap fisheries can pose a threat to sensitive benthic / habitat forming species through crushing or entanglement in gear, and damage can be incurred if the traps are dragged across the bottom by currents (DFO, 2010c). Thus, a medium level of consequence was assigned. This resulted in an overall **low** risk from the snow crab fishery to sensitive benthic / structure forming species in the AOI (Table 2.4.1-4). There was a low level of certainty

associated with this assessment because of the limited information on locations of sensitive benthic / structure forming species concentrations in the AOI.

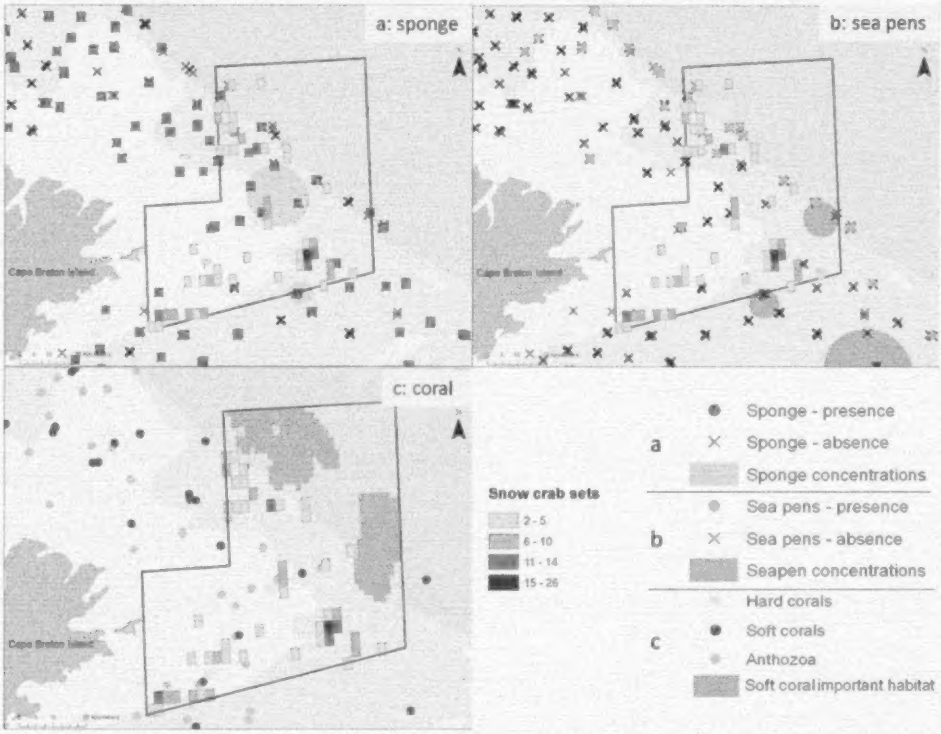

Figure 2.4.1 - 3. The spatial overlap between the snow crab fishery and a) locations of sponge presence and absence from the RV survey and sponge concentrations (modified from Kenchington et al. 2010), b) locations of sea pen presence and absence from the RV survey and sea pen concentrations (modified from Kenchington et al. 2010), c) locations of different coral types and the soft coral important habitat in and around the St. Anns Bank AOI (black polygon).

Table 2.4.1 - 4. Risk of the snow crab fishery to sensitive benthic / structure forming species in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Area of high fish diversity

The spatial overlap between the snow crab pot fishery and the area of high fish diversity was less than 10% (Figure 2.4.1-4), resulting in a low likelihood score. From available Observer data, seven fish species were caught as bycatch in approximately 0.66% of sets, resulting in a low consequence score. With a low likelihood and low consequence score, the overall risk presented

by the snow crab pot fishery to the area of high fish diversity was determined to be **low** in the AOI (Table 2.4.1-5). There was a moderate level of certainty associated with this assessment based on the level of available fisheries data for this area.

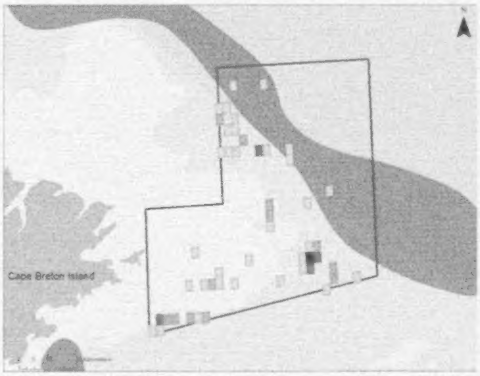

Figure 2.4.1 - 4. The spatial overlap between the snow crab fishery and the area of high fish diversity (modified from Ford and Serdynska, 2013) within the St. Anns Bank AOI (black polygon).

Table 2.4.1 - 5. Risk of the snow crab fishery to the area of high fish diversity in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

d. Atlantic cod

The spatial overlap between the snow crab pot fishery and important Atlantic cod habitat was less than 10% (Figure 2.4.1-5), resulting in a low likelihood score.

Figure 2.4.1 - 5. The spatial overlap between the snow crab fishery and important Atlantic cod habitat in the St. Anns Bank AOI (black polygon), as identified by the RV survey (Horsman and Shackell, 2009) and the sentinel survey.

Available observer data contained records of Atlantic cod in just 0.22% of sets (Table 2.4.1-2), which resulted in a low consequence score. As such, the overall risk presented by the snow crab pot fishery to Atlantic cod was considered to be **low** in the AOI (Table 2.4.1-6). There was a moderate level of certainty associated with this assessment based on the level of available fisheries data for this area.

Table 2.4.1 - 6. Risk of the snow crab fishery to Atlantic cod in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

e. Atlantic wolffish

The spatial overlap between the snow crab fishery and important habitat for Atlantic wolffish was approximately 10% (Figure 2.4.1-6), resulting in a low likelihood. Atlantic wolffish were found in 0.11% of observer sets in 4Vn (Table 2.4.1-2) resulting in a low consequence score. This resulted in an overall **low** level of risk from the snow crab fishery to Atlantic wolffish in the AOI (Table 2.4.1-7). There was a moderate level of certainty associated with this assessment based on the level of available fisheries data for this area.

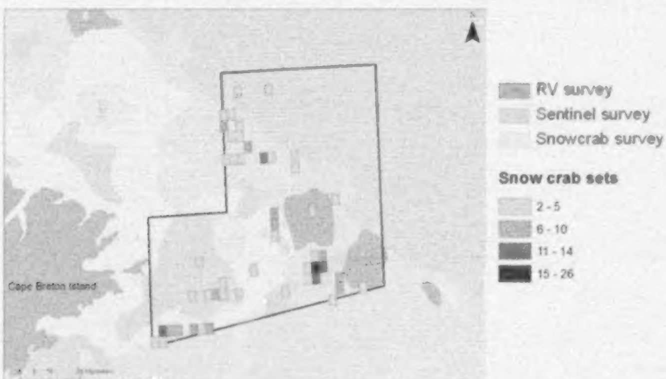

Figure 2.4.1 - 6. The spatial overlap between the snow crab fishery and important Atlantic wolffish habitat in and around the St. Anns Bank AOI (black polygon), identified through the RV survey (Horsman and Shackell, 2009), and the sentinel and snow crab survey.

Table 2.4.1 - 7. Risk of the snow crab fishery to Atlantic wolffish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

f. Redfish

The spatial overlap between the snow crab fishery and important redfish habitat was less than 10% (Figure 2.4.1-7), which resulted in a low likelihood score. There were no reports of redfish bycatch in the observer database from 4Vn, resulting in a very low consequence score. The overall risk from the snow crab fishery to redfish was considered **very low** in the AOI (Table 2.4.1-8). There was a moderate level of certainty associated with this assessment based on the level of available fisheries data for this area.

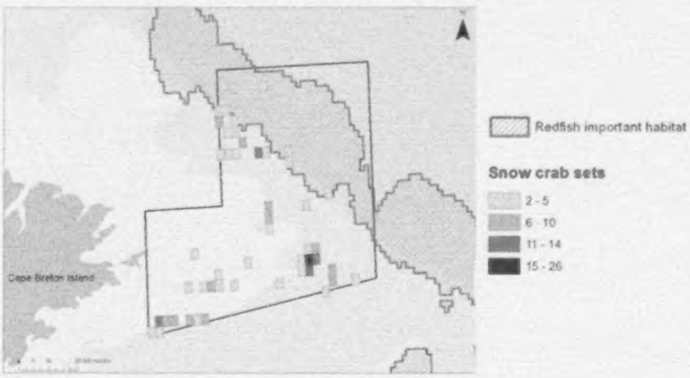

Figure 2.4.1 - 7. The spatial overlap between the snow crab fishery and important redfish habitat within the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Table 2.4.1 - 8. Risk of the snow crab fishery to important redfish habitat in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

g. American plaice

The spatial overlap between the snow crab fishery and important American plaice habitat was between 10-50% (Figure 2.4.1-8); therefore the likelihood score was considered to be medium. American plaice were caught in 0.11% of the observer sets in 4Vn (Table 2.4.1-2), resulting in a consequence score of low. The overall risk from the snow crab fishery to American plaice was considered to be **low** in the AOI (Table 2.4.1-9). There was a moderate level of certainty associated with this assessment based on the level of available fisheries data for this area.

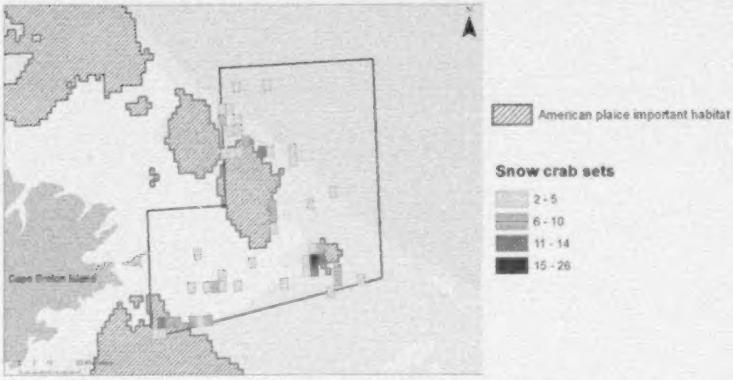

Figure 2.4.1 - 8. The spatial overlap between the snow crab fishery and important habitat for American plaice in the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Table 2.4.1 - 9. Risk of the snow crab fishery to important American plaice habitat in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

h. Leatherback turtles

The spatial overlap between the snow crab fishery and important habitat for leatherback turtles was just over 10% (Figure 2.4.1-9), resulting in a medium likelihood score.

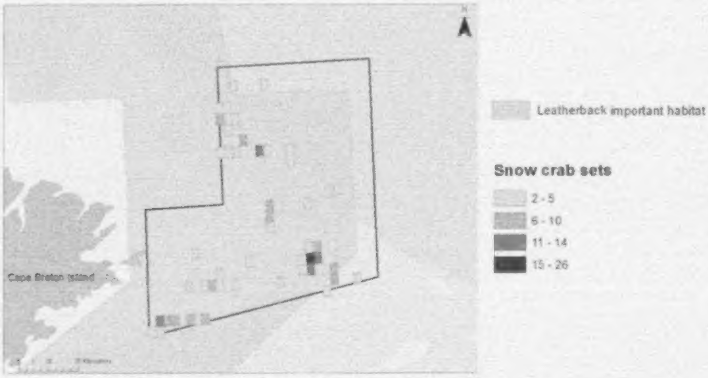

Figure 2.4.1 - 9. The overlap between the snow crab fishery and important habitat for leatherback turtles (modified from DFO, 2012f) in the St. Anns Bank AOI (black polygon).

There was one record of entanglement in the snow crab fishery in 4Vn in 2005 (Table 2.4.1-2). Between 2006-2009, three leatherback turtles were observed entangled in lines of snow crab pots on the Scotian Shelf, but all were released with little to no visible harm (Choi and Zisserson, 2011). Given available entanglement data for the region, DFO (2012g) predicts that 5.5

interactions with leatherback turtles might occur in the snowcrab fishery on the Scotian Shelf each year, with a possible mortality of 1-4 turtles per year. Taken together, a high consequence score was assigned, and the overall risk presented by the snow crab fishery to leatherback turtles was determined to be **high** in the AOI (Table 2.4.1-10). There was a moderate level of certainty associated with this assessment based on the level of available fisheries data for this area. Note that the risk is only present during the time when leatherback presence overlaps with the timing of the snow crab fishery (June to August 19th).

Table 2.4.1 - 10. Risk of the snow crab fishery to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

i. Benthic invertebrates

The main target species of this fishery is a benthic invertebrate. However, the snow crab fishery is well managed, with seasonal restrictions and total allowable catch (TAC) limits as well as mandatory dock-side monitoring (DFO, 2012h). In addition, snow crab was not identified as a specific conservation priority for the site. As such, the risk presented by the snow crab fishery to snow crab was not assessed here. Instead, this assessment focused on the risk presented by the snow crab fishery to all other benthic invertebrates in the AOI.

Benthic invertebrates as a functional group are considered to be distributed across the AOI. Because the snow crab fishery occurs in less than 10% of the site (Figure 2.4.1-2), a low likelihood score was assigned. Benthic invertebrates may be damaged or crushed by this gear type. However, for the purpose of this assessment, bycatch was considered the primary impact of concern for pot fisheries. There were eight taxa of benthic invertebrates (other than snow crab) caught as bycatch in 2.52% of sets, (Table 2.4.1-2), resulting in a low consequence score, and an overall **low** risk presented by the snow crab fishery to benthic invertebrates other than snow crab in the AOI (Table 2.4.1-11). There was a moderate level of certainty associated with this assessment based on the level of available fisheries data for this area.

Table 2.4.1 - 11. Risk of the snow crab fishery to benthic invertebrates in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

j. Demersal fish

The spatial overlap between important demersal fish habitat and the snow crab fishery was less than 10% (Figure 2.4.1-10), resulting in a low likelihood score. In addition to Atlantic cod, redfish, Atlantic wolffish, and American plaice, four species of demersal predatory fish were

caught as bycatch in 0.33% of observed sets (Table 2.4.1-2), resulting in a low consequence. The overall risk from the snow crab fishery to demersal fish was **low** in the AOI (Table 2.4.1-12). There was a moderate level of certainty associated with this assessment based on the level of available fisheries data for this area.

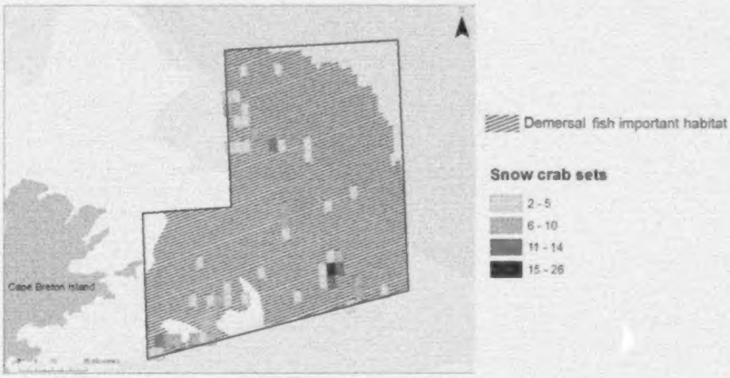

Figure 2.4.1 - 10. The spatial overlap between the snow crab fishery and important habitat for demersal fish in the St. Anns Bank AOI (black polygon).

Table 2.4.1 - 12. Risk of the snow crab fishery to demersal fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

k. Top predators

The main concern with top predators in this assessment is the possibility of marine mammal entanglements in the ropes from snow crab gear. While information is limited, marine mammals are assumed to be broadly distributed across the site. As such, because the extent of the snow crab fishery was less than 10% of the AOI, a low likelihood was assigned.

Ropes from pots and traps are known to be an entanglement risk for cetaceans (DFO, 2010c), though incidences of entanglements are low and no records of entanglements from this area were found. Some mortality of seals from snow crab fishing has been reported in PEI (Cairns et al., 2000) and Newfoundland (Fuller et al., 2008), but this is expected to be a rare occurrence with little consequence for seals at the population level. Of note, a total of 32 humpback whale entanglements in snow crab gear were reported between 1992 and 2008 off of Newfoundland and Labrador (Benjamins et al., 2011). Given this high number of entanglements of whales known to occur in the area, the consequence level was considered to be high. This resulted in an overall **medium** risk presented by the snow crab fishery to top predators in the site in the AOI (Table 2.4.1-13). There was a low level of certainty associated with this assessment because of the limited information on whale species presence and abundance in the site.

Table 2.4.1 - 13. Risk of the snow crab fishery to top predators in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

2.4.2 Lobster Pot Fishery

The St. Anns Bank AOI is in Lobster Fishing Area (LFA) 27, which includes most of Cape Breton. In 2009, there were a total of 524 licences in LFA 27 out of 2992 in the Maritimes Region (DFO, 2010d). The fishery is open in LFA 27 from May 15th to July 15th each year and is effort-managed rather than quota-managed, with a limited number of licences and a trap limit of 275 traps per fisher. A minimum legal size and restriction on retention of females with eggs is also in place. Overall landings within LFA 27 peaked around 1990 at 3790 t, but in recent (2008-2009) years landings have been strong, averaging over 2500 t per year (DFO, 2011a). This is about 1.3 times the mean for the period 1985-2004 (DFO, 2011a). In general, the recent increases in catch are believed to represent a significant increase in lobster abundance.

Since 2007, fishers have been reporting their catch by grid cells, which are a series of strips along the coast (Figure 2.4.2-1). The lobster fishing area of St. Anns Bank is within grid cell 350. From available data for LFA 27, just 5 to 7% of total annual landings were from grid cell 350 during the period of 2008-2010. Other than this coarse information from fisheries data, there is no information (such as from surveys etc.) which would allow evaluation of the importance of the St. Anns Bank AOI to lobster populations or lobster fisheries in LFA 27.

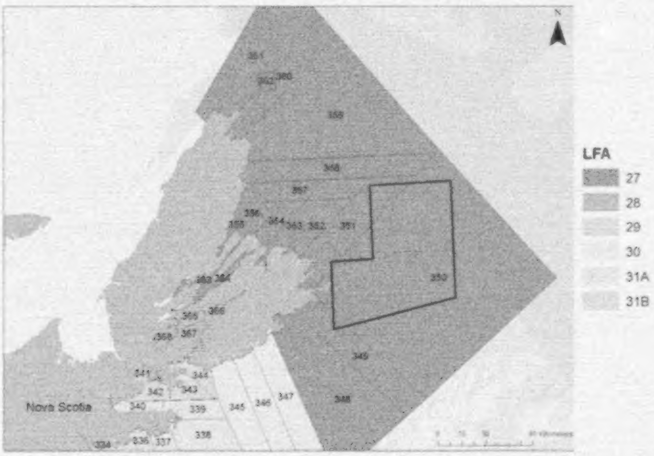

Figure 2.4.2 - 1. Lobster grid cells in the area of the St. Anns Bank AOI (modified from Coffen-Smout et al., 2013).

Because there were no available At-Sea Observer data for the lobster fishery, information on bycatch for this fishery in the St. Anns Bank area was taken from an experimental investigation by den Heyer et al., (2010). This study examined the catch in 900 lobster traps in LFA 27 (as

well as 1637 traps elsewhere in the province). The number of individuals of each species caught in the 900 traps sampled from LFA 27 is shown in Table 2.4.2-1. Species caught elsewhere on the Scotian shelf but not in LFA 27 include Jonah crab, snow crab, toad crab, green crab, monkfish, goosefish, angler fish, blennies, shannies, gunnels, sculpin, lumpfish, Atlantic spiny lumpsucker, hydrozoan, jellyfish, asterias, blood star, sand dollars, brittle star, limpet, whelk, spindle shell, New England Neptune, brown rockweed, brown seaweeds, kelp, sponges and red seaweeds.

Table 2.4.2 - 1. Number of individuals caught by species in 900 traps sampled from LFA 27 (data from den Heyer et al., 2010).

Species	# of individuals	% of catch
American lobster	2015	74.68
Atlantic rock crab	401	14.86
Purple starfish	85	3.15
Shortfin sculpin	49	1.82
Cunner	40	1.48
Periwinkles	28	1.04
Sea urchins	17	0.63
Sea raven	12	0.44
Winter flounder	10	0.37
Wave whelk, common edible	9	0.33
Hermit crabs	8	0.30
Cod (Atlantic)	7	0.26
Ocean pout	5	0.19
Rock gunnel (eel)	4	0.15
Northern moonsnail	4	0.15
Toad crab (unidentified)	1	0.04
Longhorn sculpin	1	0.04
Mussels	1	0.04
Dog whelks	1	0.04
All fish species	128	4.74
Benthic invertebrates (other than lobster)	600	22.24
Demersal fish (non-depleted)	121	4.48

Because lobster catches are reported by grid square rather than catch location, they can be difficult to map. Lobster fishing in the area is most likely to occur in depths of 50 m or less (John Tremblay, DFO Science, personal communication). A local ecological knowledge study was also conducted to determine where lobster is currently being fished, and most of the fishing occurred within the 50 m bathymetric contour line (Squires and Gromack, 2013). For the purposes of this risk assessment, the spatial extent of the lobster fishery includes the area below 50 m in depth and the areas identified in Squires and Gromack (2013; Figure 2.4.2-2). It is important to note that the lobster fishery in LFA27 is only open from May 15- July 15 so any risk associated with this fishery is only present in the AOI during that time period.

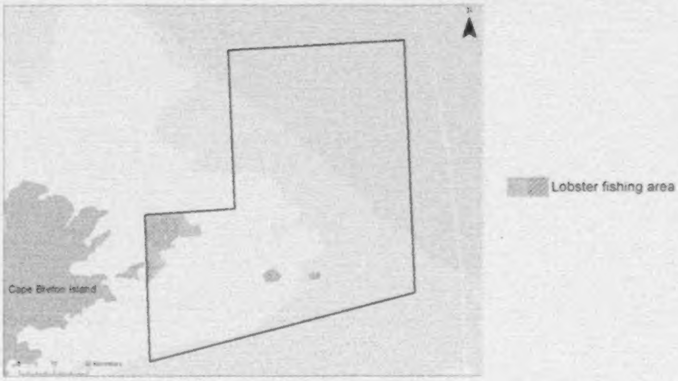

Figure 2.4.2 - 2. Lobster fishing in St. Anns Bank. The pink area is the spatial extent of the lobster fishery and the hatched areas are where fishermen reported having fished lobster in the AOI (modified from Squires and Gromack, 2013).

Risk of the Lobster Pot Fishery to the Conservation Priorities

a. Benthic habitats

The lobster fishing area covers approximately 3.55% of the AOI (Figure 2.4.2-2), resulting in a low likelihood score.

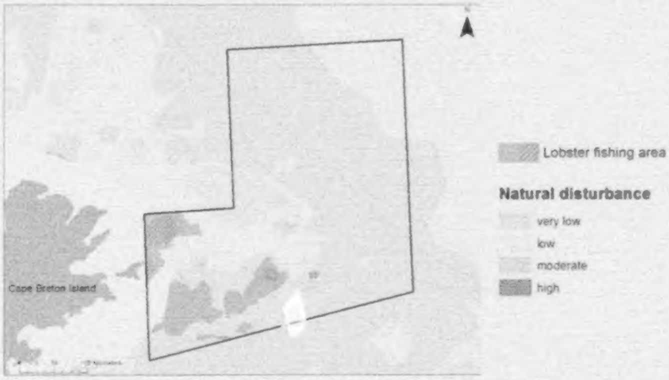

Figure 2.4.2 - 3. The spatial overlap between the inshore lobster fishery (modified from Squires and Gromack, 2013) and the levels of natural disturbance (modified from Ford and Serdynska, 2013) in benthic habitats within the St. Anns Bank AOI (black polygon).

Lobster traps have the potential to scour benthic habitats if they are dragged across the bottom during retrieval or through strong currents (DFO, 2010d). Lobster pots, like snow crab pots are a fixed bottom gear and from available data fishing occurs primarily in areas with moderate to high levels of natural disturbance (Figure 2.4.2-3), so the consequence was scored as low. This resulted in an overall **low** risk score presented by lobster fishing to benthic habitats in the AOI (Table 2.4.2-2). There was a low level of certainty associated with this assessment based on the limited information on the extent of the lobster fishery in the AOI, and the absence of natural disturbance information near shore.

Table 2.4.2 - 2. Risk of the lobster fishery to benthic habitats in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Sensitive benthic / structure forming species

Sensitive benthic / structure forming species are considered to have a wide distribution across the AOI. The lobster fishery occurs mainly in the inshore habitats and overlaps with approximately 3.55% of the AOI. This fishery does not overlap with any of the areas identified as important habitat for sensitive benthic species (Figure 2.4.2-4). Thus, a low likelihood score was assigned.

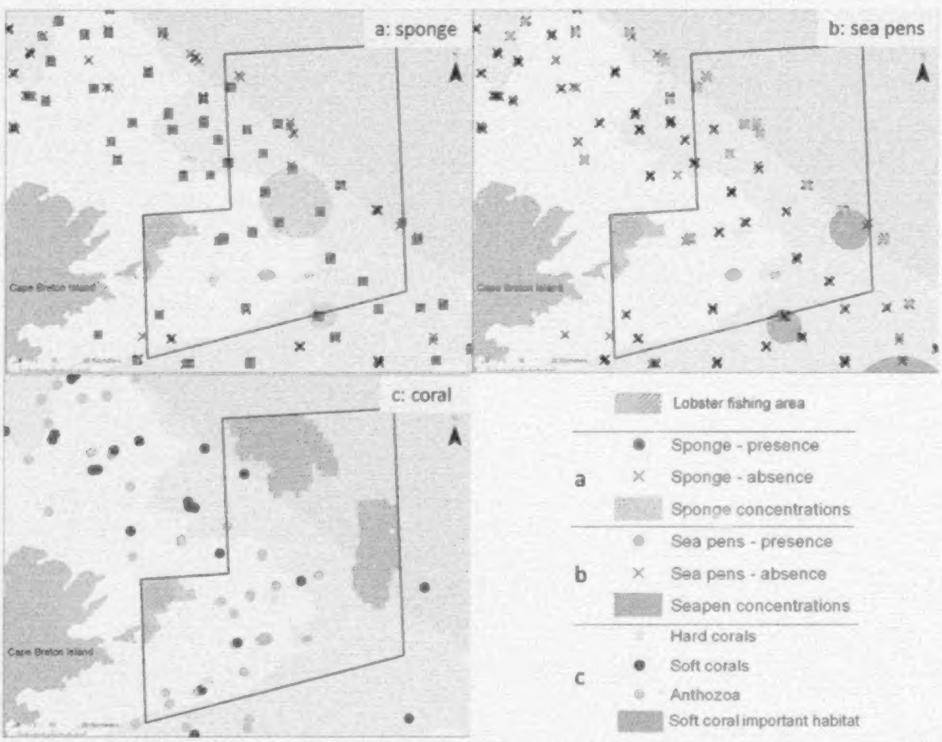

Figure 2.4.2 - 4. The spatial overlap between the inshore lobster fishery (modified from Squires and Gromack, 2013) and a) locations of sponge presence and absence from the RV survey and the sponge concentrations (modified from Kenchington et al. 2010), b) locations of sea pen presence and absence from the RV survey and the sea pen concentrations (modified from Kenchington et al. 2010), c) locations of different coral types and the soft coral important habitat in and around the St. Anns Bank AOI (black polygon). Note that the snow crab and RV surveys very rarely sample depths shallower than 50m where lobster fishing occurs.

Trap fisheries have the potential to damage or crush sensitive benthic / structure forming species and they can also become entangled in the gear (DFO, 2010c). Because damage can occasionally

occur with this gear type, the consequence level was considered to be medium. This resulted in an overall **low** risk from the lobster fishery to sensitive benthic / structure forming species in the AOI (Table 2.4.2-3). There was a very low level of certainty associated with this assessment because of the lack of knowledge of the specific locations of sensitive benthic / structure forming species concentrations in the AOI, particularly in the inshore, and the limited available data to characterize lobster bycatch or the extent of the lobster fishery in the AOI.

Table 2.4.2 - 3. Risk of the lobster fishery to sensitive benthic / structure forming species in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Area of high fish diversity

There is no spatial overlap between the lobster fishery and the area of high fish diversity (Figure 2.4.2-5), resulting in a very low likelihood. Eight fish species were caught as bycatch in the lobster fishery in 4.74% of the catch (Table 2.4.2-1), resulting in a low consequence. The overall risk from the lobster fishery to the area of high fish diversity was **very low** in the AOI (Table 2.4.2-4). There was a low level of certainty associated with this assessment based on the limited available data to characterize lobster bycatch or the extent of the lobster fishery in the AOI.

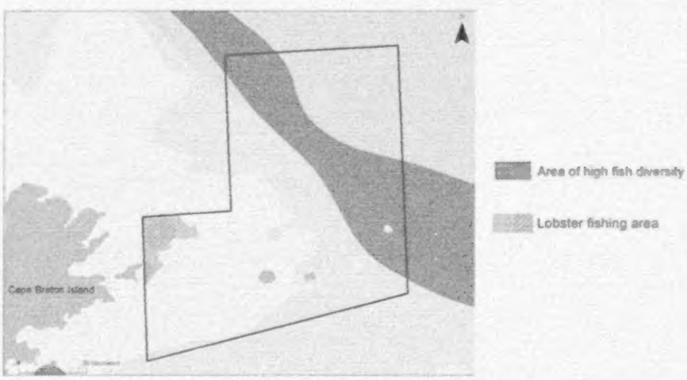

Figure 2.4.2 - 5. The spatial overlap between the lobster fishery (modified from Squires and Gromack, 2013) and the area of high fish diversity (modified from Ford and Serdynska, 2013) within the St. Anns Bank AOI (black polygon).

Table 2.4.2 - 4. Risk of the lobster pot fishery to the area of high fish diversity in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

d. Atlantic cod

The spatial overlap of the lobster pot fishery and important Atlantic cod habitat was less than 10% (Figure 2.4.2-6), resulting in a low likelihood score. In the den Heyer et al., (2010) study, 0.26% of the individuals caught were Atlantic cod (Table 2.4.2-1), which resulted in a low consequence score for this interaction. The overall risk score was **low** for the impact of the lobster pot fishery on Atlantic cod in the AOI (Table 2.4.2-5), with a low level of certainty based on the limited available data to characterize lobster bycatch or the extent of the lobster fishery in the AOI.

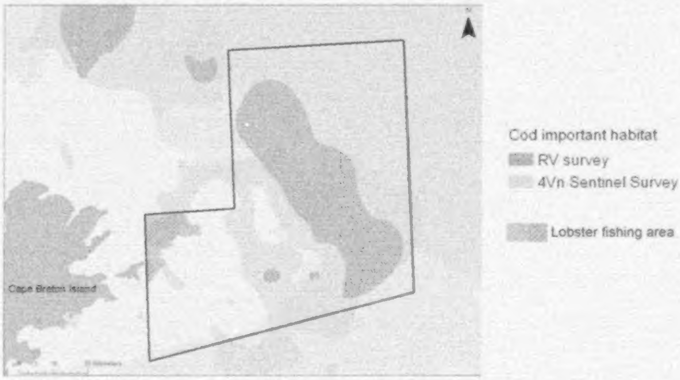

Figure 2.4.2 - 6. The spatial overlap between the lobster fishery (modified from Squires and Gromack, 2013) and important Atlantic cod habitat in and around the St. Anns Bank AOI (black polygon), identified using data from the RV survey (Horsman and Shackell, 2009) and the sentinel survey.

Table 2.4.2 - 5. Risk of the lobster fishery to Atlantic cod in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

e. Atlantic wolffish

The spatial overlap between the lobster pot fishery and important Atlantic wolffish habitat was less than 10% (Figure 2.4.2-7), resulting in a low likelihood score. While wolffish are known to be caught in lobster fisheries in other areas (Kulka et al., 2007), there were no records of Atlantic wolffish caught as bycatch in den Heyer et al. (2010) (Table 2.4.2-1), so the consequence score for this assessment was very low. This resulted in an overall risk score of **very low** for the impacts of the lobster pot fishery on Atlantic wolffish in the AOI (Table 2.4.2-6), with a low level of certainty based on the limited available data to characterize lobster bycatch or the extent of the lobster fishery in the AOI.

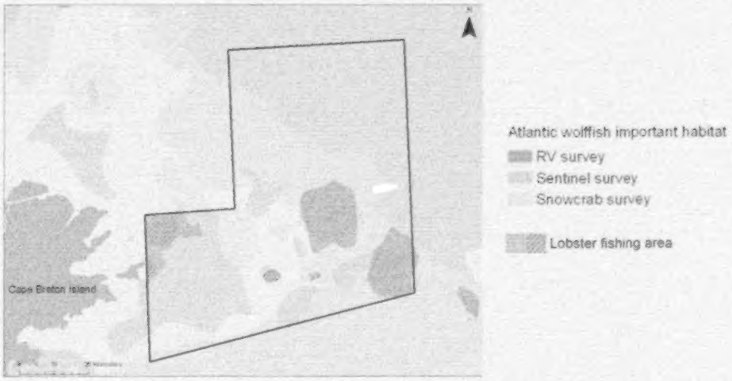

Figure 2.4.2 - 7. The spatial overlap between the lobster fishery (modified from Squires and Gromack, 2013) and important Atlantic wolffish habitat in the St. Anns Bank AOI (black polygon), identified through the RV survey (Horsman and Shackell, 2009), and the sentinel and snow crab surveys.

Table 2.4.2 - 6. Risk of the lobster fishery to Atlantic wolffish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

f. Redfish

There is no spatial overlap between the lobster fishery and the important habitat for redfish (Figure 2.4.2-8), resulting in a very low likelihood score.

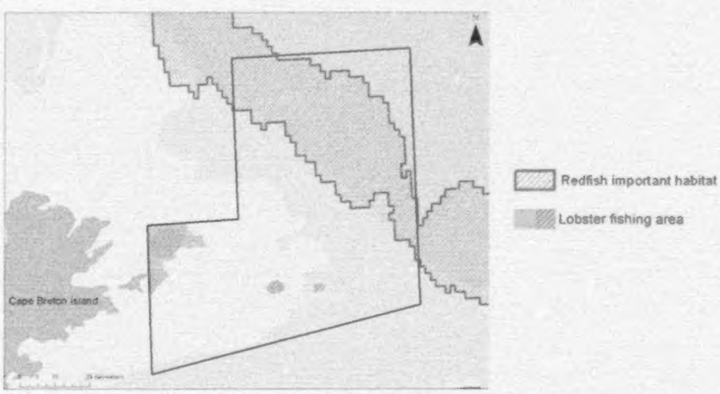

Figure 2.4.2 - 8. The spatial overlap between the lobster fishery (modified from Squires and Gromack, 2013) and important redfish habitat within the St. Anns Bank AOI (black polygon) (modified from Horsman and Shackell, 2009).

There was no redfish bycatch reported in the den Heyer et al., (2010) study (Table 2.4.2-1) so the consequence was determined to be very low. The overall risk from the lobster pot fishery to

redfish was **very low** in the AOI (Table 2.4.2-7). There is a low level of certainty associated with this assessment based on the limited available data to characterize lobster bycatch or the extent of the lobster fishery in the AOI.

Table 2.4.2 - 7. Risk of the lobster fishery to redfish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

g. American plaice

There is no spatial overlap between the lobster fishery and the important habitat for American plaice (Figure 2.4.2-9), resulting in a very low likelihood. There were no American plaice caught as bycatch in the Heyer et al., (2010) study (Table 2.4.2-1), which resulted in a very low consequence. The overall risk from the lobster pot fishery to American plaice was **very low** in the AOI (Table 2.4.2-8). There is a low level of certainty associated with this assessment based on the limited available data to characterize lobster bycatch or the extent of the lobster fishery in the AOI.

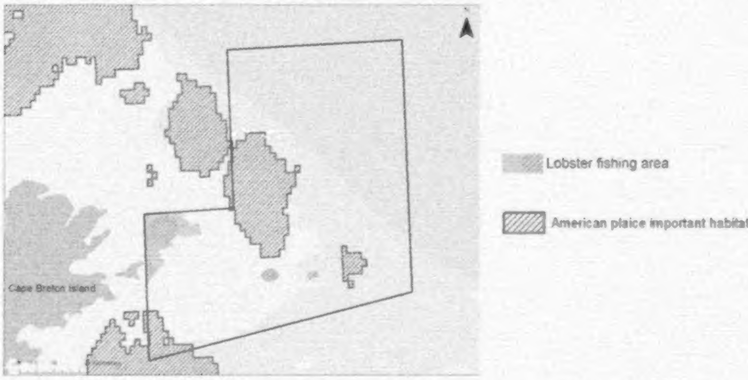

Figure 2.4.2 - 9. The spatial overlap between the lobster fishery (modified from Squires and Gromack, 2013) and important habitat for American plaice in the St. Anns Bank AOI (black polygon) (modified from Horsman and Shackell, 2009).

Table 2.4.2 - 8. Risk of the lobster fishery to American plaice in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

h. Leatherback turtles

The spatial overlap between the lobster pot fishery and important habitat for leatherback turtles was approximately 4% (Figure 2.4.2-10), resulting in a low likelihood score (note, the lobster fishing season in LFA27 is open from May 15 – July 15, which partially overlaps with the summer foraging season when leatherback turtles are expected to be in the area). There has been one leatherback entanglement record in *SARA* logbooks from the lobster fishery on the Scotian Shelf, and one report in the Quebec Region (DFO, 2012g). With two documented entanglements in eastern Canadian waters, a medium consequence score was assigned. This resulted in a **low** risk from the lobster pot fishery to leatherback turtles in the AOI (Table 2.4.2-9). This risk is only present during June and July when the turtles are in the area during the fishing season. There was a low level of certainty associated with this assessment based on limited available data to characterize the lobster fishery in the AOI.

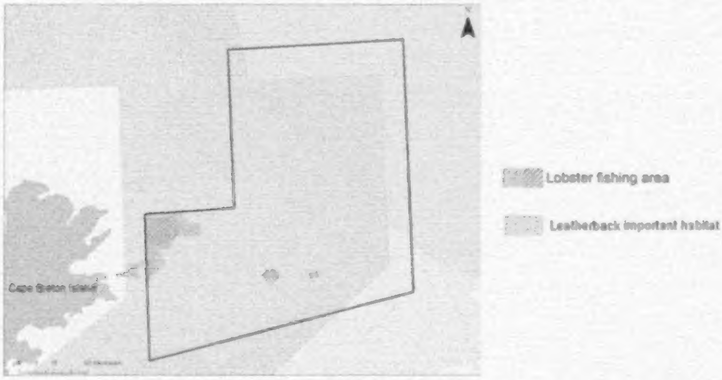

Figure 2.4.2 - 10. The spatial overlap between the important habitat for leatherback turtles (modified from DFO, 2012f) and the lobster fishery (modified from Squires and Gromack, 2013).

Table 2.4.2 - 9. Risk of the lobster fishery to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

i. Benthic invertebrates

Lobsters are benthic invertebrates, and the target of the lobster pot fishery. However, this fishery is managed by DFO, with seasonal restrictions, limits on the number of licences per LFA, and limits on trap numbers per licence holder. As well, lobster was not identified as a specific conservation priority for the site. As such, benthic invertebrates other than lobster were the focus of the assessment for this functional group.

The spatial extent of benthic invertebrates was considered to be the extent of the benthic habitats within the AOI, thus there was less than 10% habitat overlap with the lobster pot fishery, resulting in a low likelihood score. Benthic invertebrates may be damaged or crushed by lobster

pots. However, for the purpose of this assessment, bycatch was considered the primary impact of concern for pot fisheries. Benthic invertebrates (other than lobster) were found in 22.24% of the catch (Table 2.4.2-1) resulting in a low consequence score. The overall risk of the lobster pot fishery to benthic invertebrates (other than lobster) was **low** in the AOI (Table 2.4.2-10). A low level of certainty was associated with this assessment based on the limited information on bycatch and the limited data available to characterize the extent of the lobster fishery in the AOI.

Table 2.4.2 - 10. Risk of the lobster pot fishery to benthic invertebrates in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

j. Demersal fish

The spatial overlap between the inshore lobster fishery and the important habitat for demersal fish was less than 10% (Figure 2.4.2-11), resulting in a low likelihood score. The lobster fishery is generally a low bycatch fishery. In addition to Atlantic cod, American plaice, redfish and Atlantic wolffish, seven demersal fish species were caught as bycatch in 4.48% of the catch, (Table 2.4.2-1), resulting in a low consequence score. The overall risk to demersal fish from the lobster pot fishery was considered to be **low** in the AOI (Table 2.4.2-11). There was a low level of certainty associated with this assessment based on the limited information on bycatch and limited data available to characterize the extent of the lobster fishery in the AOI.

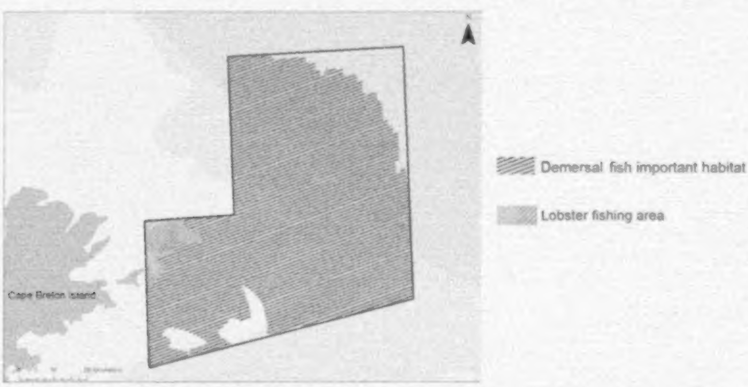

Figure 2.4.2 - 11. The spatial overlap between the inshore lobster fishery (modified from Squires and Gromack, 2013) and important habitat for demersal fish in the St. Anns Bank AOI (black polygon).

Table 2.4.2 - 11. Risk of the lobster pot fishery to demersal fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

k. Top predators (whales)

Whales are migratory through the AOI, but some species may remain in the area throughout the year. With the lack of available information on the presence of whale species in the AOI, whales were considered to be broadly distributed across the site. Less than 10% of the AOI overlaps with the lobster pot fishery, resulting in a low likelihood score. Ropes from pots and traps are known to be an entanglement risk for cetaceans (DFO, 2010c), and there are reports of 3 right whale and 5 humpback whale entanglements in lobster gear in the northwest Atlantic (Johnson et al., 2005). Given the short fishing season, and the fact that some entanglements have occurred in northwest Atlantic waters, a medium consequence score was assigned. The overall risk score for the risk of the lobster pot fishery to top predators (whales) was **low** in the AOI (Table 2.4.2-12), with a low level of certainty based on the limited information on the lobster fishery in the area, and the lack of information on whale presence and abundance in the area.

Table 2.4.2 - 12. Risk of the lobster pot fishery to top predators in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

2.4.3 Groundfish (Redfish) Otter Trawl

The groundfish otter trawl fishery is active in and around the AOI and targets two species of redfish, *S. mentella* and *S. fasciatus*. The redfish fishery is open year round and is managed in two units; Unit 1, which is managed from January to May (4RST + 3Pn4Vn), and Unit 2, which is managed from June to December (3Ps4Vs4Wfgj + 3Pn4Vn). The Unit 1 directed trawl fishery was closed in 1995 as a result of low stock abundance and the absence of significant recruitment (DFO, 2011a). The directed fishery has remained closed since then, however a small index fishery was established in 1998 and has continued with an annual allocation of 2000 tonnes. The Unit 2 fishery remains open with a total allowable catch of 8500 tonnes. Landings from the redfish fishery in the St. Anns Bank AOI reported between 2000 and 2010 are shown in Table 2.4.3-1.

Table 2.4.3 - 1. Total redfish landings from the St. Anns Bank AOI from 2000 – 2010 from all gear types.

Year	Landings (mt)
2000	208.22
2001	147.15
2002	193.50
2003	152.92
2004	246.34
2005	74.97
2006	60.21
2007	40.09
2008	21.90
2009	37.49
2010	25.16

Observer records of the groundfish otter trawl fishery in the area go back to the 1980's, however due to changes in the ecosystem and the fishery, that data may no longer be representative. Therefore, only the redfish otter trawl sets in the observer database for 4Vn from 2000-2010 were used to characterize bycatch in the fishery (Table 2.4.3-2).

Table 2.4.3 - 2. Observer data for the redfish otter trawl fishery in 4Vn from 2000-2010. The number of sets refers to the number of sets that the species occurred in and the percentage of sets is the percent of the total number of sets that the species occurred in.

Species	# of sets	% of sets	Species	# of sets	% of sets
Redfish	73	93.59	Paguroidea S.F.	4	5.13
Turbot	67	85.90	Spiny dogfish	4	5.13
Thorny Skate	51	65.38	Rock grenadier	3	3.85
Witch flounder	50	64.10	Silver hake	3	3.85
Black dogfish	44	56.41	Spotted wolffish	3	3.85
White hake	38	48.72	Atlantic wolffish	3	3.85
Cod (Atlantic)	34	43.59	Barndoor skate	2	2.56
Monkfish, goosefish	32	41.03	Cusk	2	2.56
Halibut (Atlantic)	24	30.77	Herring (Atlantic)	2	2.56
Smooth Skate	20	25.64	Longfin hake	2	2.56
Jellyfishes	16	20.51	Northern wolffish	2	2.56
Pollock	13	16.67	Sea raven	2	2.56
Skates	13	16.67	Capelin	1	1.28
Short-fin squid	12	15.38	Eelpouts	1	1.28
Grenadiers	9	11.54	Haddock	1	1.28
Hake	8	10.26	Octopus	1	1.28
Lumpfish	8	10.26	Porcupine crab	1	1.28
Asteroidea S.C.	7	8.97	Snow crab (Queen)	1	1.28
Northern stone crab	7	8.97	Sponges	1	1.28
Shrimps	7	8.97	Wrymouth	1	1.28
Letharchus aliculatus	5	6.41	All fish species (excluding redfish)	78	100
Sea anemone	5	6.41	Benthic invertebrates	30	38.46
American plaice	4	5.13	Demersal fish (non-depleted)	78	100

The spatial extent of the redfish otter trawl fishery in the AOI was determined by binning the number of fishing sets reported in fisheries logbooks from 1999-2009 into 2x2 minute grid cells (~10 km^2) grid cells (Figure 2.4.3-1). Cells containing two or more sets were used to define the spatial extent of the fishery in the AOI.

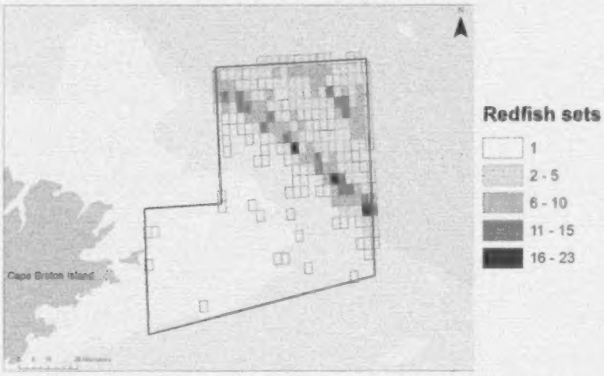

Figure 2.4.3 - 1. The spatial extent of the redfish otter trawl fishery between 1999-2009 within the AOI (total 1576 km^2). Grid cells containing only one recorded set were not included as part of the fishing footprint.

Risk of the Redfish Otter Trawl Fishery to the Conservation Priorities

a. Benthic habitats

The redfish otter trawl fishery overlapped with approximately 30% of the AOI and it was almost exclusively over the slope habitat (Figure 2.4.3-2), resulting in a medium likelihood.

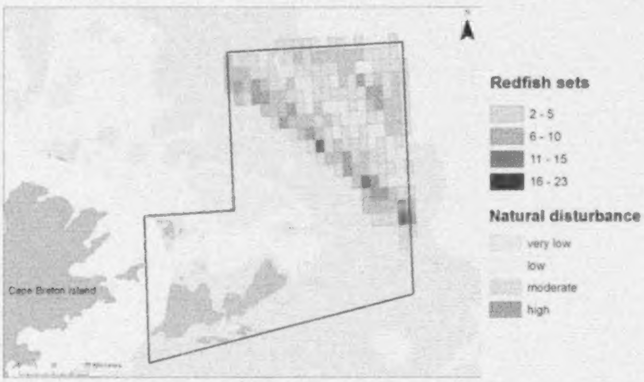

Figure 2.4.3 - 2. The spatial overlap between the redfish otter trawl fishery and the levels of natural disturbance (modified from Ford and Serdynska, 2013) in benthic habitats within the St. Anns Bank AOI (black polygon).

Benthic trawling gear has the potential to damage or reduce the complexity of benthic habitats and alter the structure of the sea floor (DFO, 2006). While the majority of the redfish trawl fishery footprint occurred in areas of moderate natural disturbance, approximately 25% of the fishery overlapped with areas of low natural disturbance (Figure 2.4.3-2). Therefore, consequence level was assigned as high. This resulted in an overall **high** risk from the redfish

otter trawl fishery to benthic habitats in the AOI (Table 2.4.3-3). There was a moderate level of certainty associated with this assessment based on the available fisheries data and the known impacts of the gear type on benthic habitats (DFO, 2006).

Table 2.4.3 - 3. Risk of the redfish otter trawl fishery to benthic habitats in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Sensitive benthic / structure forming species

Sensitive benthic / structure forming species are assumed to be broadly-distributed across the AOI, and the redfish otter trawl fishery overlaps with most of the area identified as a soft coral important habitat and approximately half of the area identified as a sea pen concentration. Because the redfish otter trawl fishery footprint covers approximately 30% of the site (Figure 2.4.3-3), a medium likelihood score was assigned.

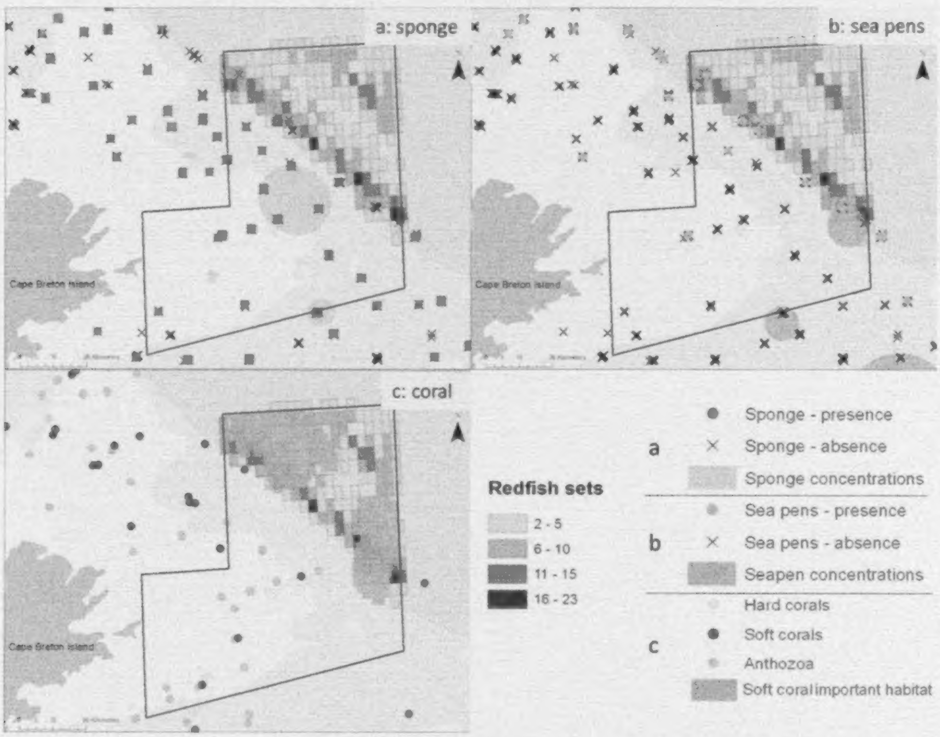

Figure 2.4.3 - 3. The spatial overlap between the redfish otter trawl fishery and locations of a) sponge presence and absence from the RV survey and the sponge concentrations (modified from Kenchington et al. 2010), b) sea pen presence and absence from the RV survey and the sea pen concentrations (modified from Kenchington et al. 2010), c) different coral types and the soft coral important habitat in and around the St. Anns Bank AOI (black polygon).

Mobile bottom-contacting gears can damage or reduce structural biota and habitat complexity, altering seafloor structure and habitat features (DFO, 2006). These gear types can also change the relative abundance of species, in part by decreasing the abundance of species with low turnover rates and increasing the abundance of species with high turnover rates. Because redfish otter trawl gear is known to cause such impacts, the consequence level was scored as high. This resulted in an overall **high** risk from the redfish otter trawl fishery to sensitive benthic / structure forming species in the AOI (Table 2.4.3-4). There was a low level of certainty associated with this assessment based on the limited knowledge of the exact locations of sensitive benthic / structure forming species in the site.

Table 2.4.3 - 4. Risk of the redfish otter trawl fishery to sensitive benthic / structure forming species in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Area of high fish diversity

The redfish otter trawl fishery overlaps more than 50% of the area of high fish diversity (Figure 2.4.3-4), which resulted in a high likelihood score. From available observed data, this fishery has a high amount of fish bycatch, with over 30 bycatch species caught in 100% of observed sets (Table 2.4.3-2). Because of these high bycatch levels, the consequence was considered to be high. This resulted in an overall **high** risk from the redfish fishery to the area of high fish diversity in the AOI (Table 2.4.3-5). There was a moderate level of certainty associated with this assessment based on the available observer coverage and catch and effort data associated with this fishery.

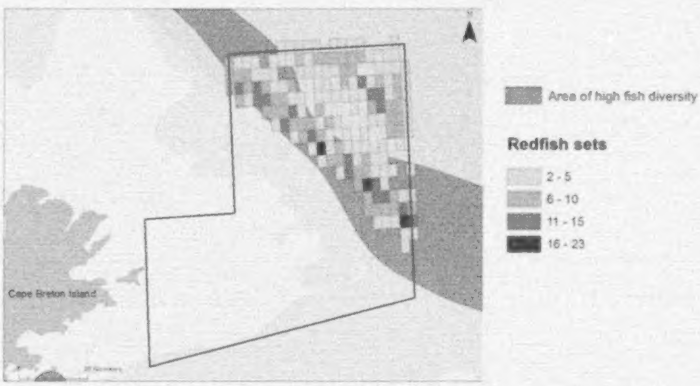

Figure 2.4.3 - 4. The spatial overlap between the redfish otter trawl fishery and the area of high fish diversity (modified from Ford and Serdynska, 2013) within the St. Anns Bank AOI (black polygon).

Table 2.4.3 - 5. Risk of the redfish otter trawl fishery to the area of high fish diversity in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

f. Atlantic cod

The redfish otter trawl fishery overlaps with approximately 20% of the important Atlantic cod habitat (Figure 2.4.3-5), resulting in a medium likelihood score. Atlantic cod were found in over 40% of observed sets (Table 2.4.3-2), so the consequence level was scored as high. This resulted in an overall **high** risk to Atlantic cod from the redfish otter trawl fishery in the AOI (Table 2.4.3-6). There was a moderate level of certainty associated with this assessment based on the available observer coverage and catch and effort data associated with this fishery.

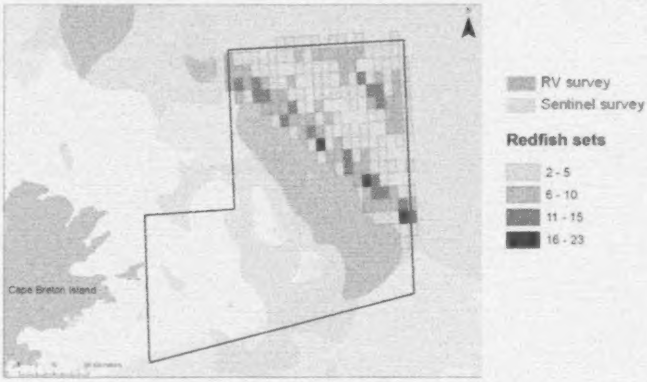

Figure 2.4.3 - 5. The spatial overlap between the redfish otter trawl fishery and important Atlantic cod habitat in and around the St. Anns Bank AOI (black polygon), identified using the RV survey (Horsman and Shackell, 2009) and the sentinel survey.

Table 2.4.3 - 6. Risk of the redfish otter trawl fishery to Atlantic cod in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

g. Atlantic wolffish

The redfish otter trawl fishery overlaps with less that 10% of the Atlantic wolffish habitat in the AOI (Figure 2.4.3-6), resulting in a low likelihood score. Atlantic wolffish were found in 3.85% of observer sets (Table 2.4.3-2), resulting in a medium consequence score and an overall **low** risk from the redfish otter trawl fishery to Atlantic wolffish in the AOI (Table 2.4.3-7). There was a

moderate level of certainty associated with this assessment based on the available observer coverage and catch and effort data associated with this fishery.

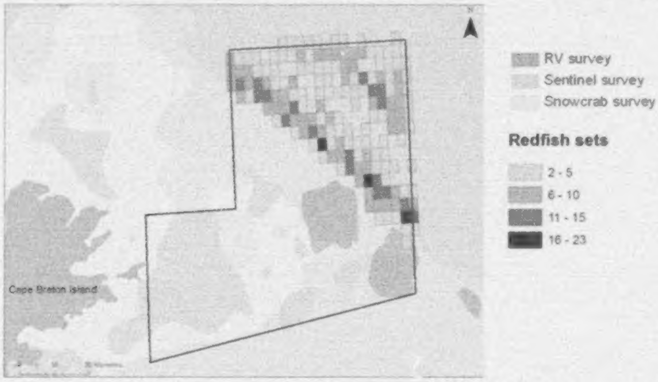

Figure 2.4.3 - 6. The spatial overlap between the redfish otter trawl fishery and Atlantic wolffish habitat in the St. Anns Bank AOI (black polygon), identified through the RV survey (Horsman and Shackell, 2009), and the sentinel and snow crab survey.

Table 2.4.3 - 7. Risk of the redfish otter trawl fishery to Atlantic wolffish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

h. Redfish

Redfish are the target species of the redfish otter trawl fishery. Based on the most recent stock assessment (McAllister and Duplisea, 2011), the Laurentian Channel (Unit 2) population of *S. fasciatus* is considered to be able to support a fishery. For *S. mentella*, the stock is still considered depleted, with little prospect of any allowable harm.

While the fishery is managed by DFO and the risk posed by the otter trawl fishery to the redfish population region-wide may be low, redfish have been identified as a depleted species and conservation priority for the future St. Anns Bank MPA. Thus, an assessment of the risks presented by the redfish otter trawl fishery to the redfish population in the AOI was conducted using the same method applied to other fisheries in the site.

The spatial overlap between the redfish otter trawl fishery and the important redfish habitat was over 50% (Figure 2.4.3-7), resulting in a high likelihood. Redfish were found in 93% of observer sets (Table 2.4.3-2), which placed the consequence level at high. This resulted in an overall **high** risk to redfish from the redfish otter trawl fishery in the AOI (Table 2.4.3-8). Given that redfish are the target of this fishery, a high level of certainty was associated with this risk score.

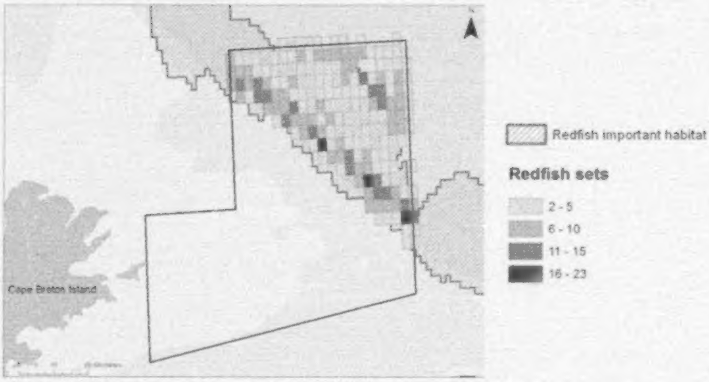

Figure 2.4.3 - 7. The spatial overlap between the redfish otter trawl fishery and important redfish habitat within the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Table 2.4.3 - 8. Risk of the redfish otter trawl fishery to redfish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

i. American plaice

There was no direct overlap between the redfish otter trawl fishery and the area identified as important habitat for American plaice (Figure 2.4.3-8). Thus, the likelihood score was considered to be very low.

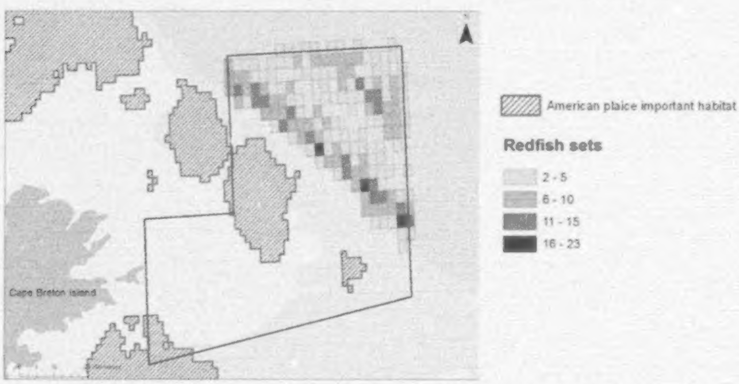

Figure 2.4.3 - 8. The spatial overlap between the redfish otter trawl fishery and important habitat for American plaice in and around the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

However, American plaice were caught in over 5% of observer sets (Table 2.4.3-2), resulting in a consequence level of high. This resulted in an overall **low** risk to American plaice from the

redfish otter trawl fishery in the AOI (Table 2.4.3-9). There was a moderate level of certainty associated with this assessment based on the available observer coverage and catch and effort data associated with this fishery.

Table 2.4.3 - 9. Risk of the redfish otter trawl fishery to American plaice in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

j. Leatherback turtles

The redfish otter trawl fishing area overlaps with just over 10% of the important habitat for leatherback turtles within the AOI (Figure 2.4.3-9), resulting in a medium likelihood. Interactions between otter trawls and leatherback are considered rare, and there has been just one record of a leatherback being caught in trawl gear in the Gulf of St Lawrence (DFO, 2012g). As such, a low consequence score was assigned, and the overall risk to leatherback turtles from redfish otter trawling was scored as **low** in the AOI (Table 2.4.3-10). This risk is only present during the summer foraging season when turtles are in the area. There was a low level of certainty associated with this assessment based on the limited information about otter trawl interactions with leatherback turtles.

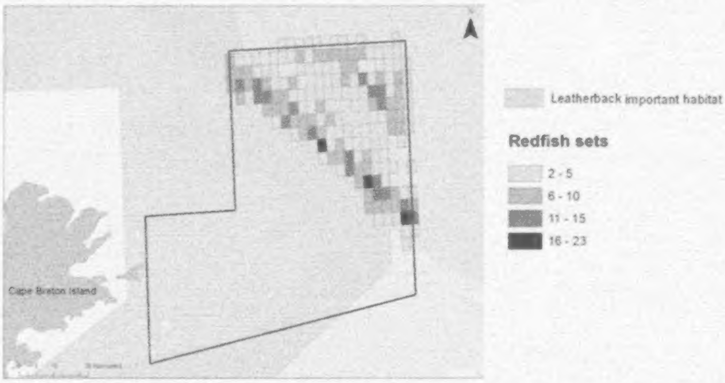

Figure 2.4.3 - 9. The spatial overlap of the important habitat for leatherback turtles (modified from DFO, 2012f) with redfish otter trawl fishing area.

Table 2.4.3 - 10. Risk of the redfish otter trawl fishery to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

k. Benthic invertebrates

Benthic invertebrates as a functional group are considered widely distributed throughout the entire AOI. Because the redfish otter trawl fishery overlaps with approximately 30% of the site, a medium likelihood score was assigned. Benthic invertebrates were found in over 38.46% of observed sets for the redfish otter trawl fishery in the area (Table 2.4.3-2), which resulted in a medium consequence level. This resulted in an overall **medium** risk to benthic invertebrates from the redfish otter trawl fishery in the AOI (Table 2.4.3-11). There was a moderate level of certainty associated with this assessment based on the available observer coverage and catch and effort data associated with this fishery.

Table 2.4.3 - 11. Risk of the redfish otter trawl fishery to benthic invertebrates in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

l. Forage fish

Forage fish are considered widely distributed across the entire AOI. The spatial extent of the redfish otter trawl fishery covers approximately 30% of the site, resulting in a medium likelihood. From available observer data, herring were found in 2.56% of sets and capelin were found in 1.28% of observed sets (Table 2.4.3-2), resulting in a low consequence score, and an overall **low** risk presented by the redfish otter trawl fishery to forage fish in the AOI (Table 2.4.3-12). There was a low certainty level associated with this risk score based on the limited information on the distribution and abundance of forage fish in the site.

Table 2.4.3 - 12. Risk of the redfish otter trawl fishery to forage fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

m. Demersal fish

Approximately 25% of the redfish otter trawl fishery overlaps with the combined demersal fish habitat identified in the site (Figure 2.4.3-10), resulting in a medium likelihood. In addition to redfish, Atlantic cod, American plaice, and Atlantic wolffish (assessed above), 26 demersal fish species were caught as bycatch in 100% of the observed sets (Table 2.4.3-2), resulting in a high consequence score. This resulted in an overall **high** risk from redfish otter trawling to demersal fish in the AOI (Table 2.4.3-13). There was a moderate level of certainty associated with this assessment based on the available observer coverage and catch and effort data associated with this fishery.

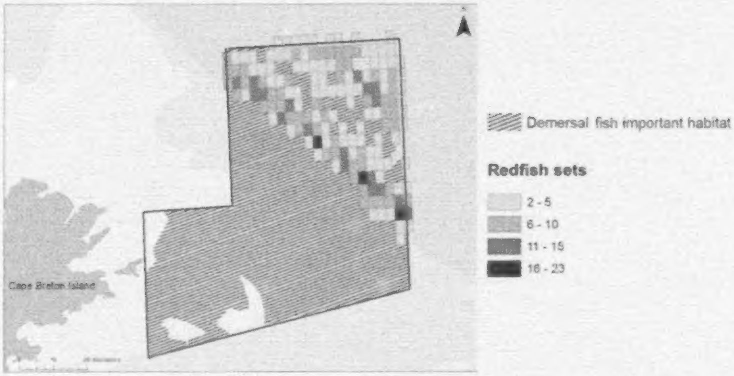

Figure 2.4.3 - 10. The spatial overlap between the redfish otter trawl fishery and habitat for demersal fish in the St. Anns Bank AOI (black polygon).

Table 2.4.3 - 13. Risk of the redfish otter trawl fishery to demersal fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

n. Top predators

Top Predators are presumed to be widely distributed throughout the AOI resulting in a spatial overlap of approximately 30% with the redfish otter trawl fishery, and a medium level of likelihood. While the impacts of trawling on marine mammals are not well known, one study conducted in the northeastern United States postulated that marine mammal bycatch from otter trawling gear may be high (National Marine Fisheries Service, 2011). However, there have been no records indicating marine mammal or large shark bycatch occurs in the otter trawl fishery in this region. Thus, the consequence score was assigned as low. This resulted in an overall **low** risk from the redfish otter trawl fishery to sharks in the AOI (Table 2.4.3-14). There was a low level of certainty associated with this assessment based on the limited available information about shark distribution and abundance in the site.

Table 2.4.3 - 14. Risk of the redfish otter trawl fishery to top predators (sharks) in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

2.4.4 Groundfish (Redfish) Midwater Trawl

There are no records of midwater trawling in the AOI since 1998, though it was a commonly used gear in the 1980s and early 1990s. There has been a small amount of midwater trawling in 4Vn in recent years, but it has mainly taken place in the deeper parts of the Laurentian Channel outside of the AOI. While there is currently no active midwater trawl fishery within the AOI, there have been some expressions of interest in replacing otter trawls with lower-impact midwater trawls to target redfish in the area. Therefore, an assessment of risks presented by a potential redfish midwater trawl fishery to the conservation priorities for the future St. Anns Bank MPA has been conducted.

There were 84 observed redfish trips using midwater trawls in 4Vn between 1990 and 1999 (Table 2.4.4-1), and these sets were used to characterize bycatch associated with this fishery. It is important to note that because the majority of these sets were observed during the early 1990s, species distributions and abundances may have changed considerably since then. Therefore, consequences scores based on the bycatch profile provided in Table 2.4.4-1 are associated with a low level of certainty.

Table 2.4.4 - 1. Observer data for the redfish midwater trawl fishery in 4Vn from 1990-1999.

Species	# of sets	% of sets	Species	# of sets	% of sets
Redfish	935	99.89	Atlantic halibut	3	0.32
Atlantic cod	608	64.96	Pandalus Sp.	3	0.32
Hake	475	50.75	Capelin	3	0.32
Jellyfishes	413	44.12	Roughhead grenadier	3	0.32
Lumpfish	231	24.68	Northern wolffish	3	0.32
Black dogfish	163	17.41	Blue shark	2	0.21
Pollock	126	13.46	Roughhouse grenadier	2	0.21
Sand lance	97	10.36	Wolffish	1	0.11
White hake	77	8.23	Winter flounder	1	0.11
Grenadiers	41	4.38	Argentines	1	0.11
Longfin hake	37	3.95	Spider crab	1	0.11
Skates	34	3.63	American plaice	1	0.11
Spiny dogfish	31	3.31	Spinytail skate	1	0.11
Haddock	31	3.31	Spiny eel	1	0.11
Squirrel or red hake	27	2.88	Toadfish	1	0.11
Barracudinea	23	2.46	Basking shark	1	0.11
Silver hake	18	1.92	Marlin-spike grenadier	1	0.11
Atlantic herring	14	1.50	Longnose grenadier	1	0.11
Porbeagle	12	1.28	Deepsea angler	1	0.11
Rock grenadier	10	1.07	Shortfin mako	1	0.11
Short-fin squid	9	0.96	Brachiuran crabs	1	0.11
Atlantic mackerel	9	0.96	Shanny	1	0.11
Atlantic argentine	8	0.85	Lophiiformes	1	0.11
Monkfish, goosefish	7	0.75	Greenland shark	1	0.11
Seals	7	0.75	Spotted wolffish	1	0.11
Dogfishes	7	0.75	All fish species (excluding redfish)	162	81.41
Turbot	4	0.43	Benthic invertebrates	12	1.28
Witch flounder	4	0.43	Demersal fish (non-depleted)	664	70.94
Skates and rays	4	0.43			

For the purposes of this assessment, the spatial footprint of the fishery was assumed to be the same as the spatial extend of the redfish otter trawl fishery, because the target species is the same (Figure 2.4.4-1). The fishing season was also assumed to be year round, aligning with the redfish otter trawl fishing season.

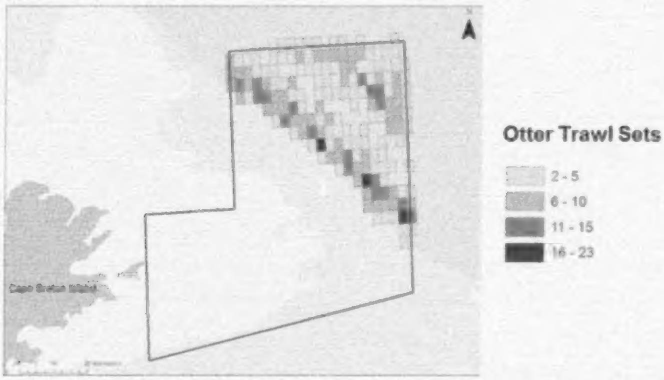

Figure 2.4.4 - 1. The spatial extent of the current redfish otter trawl fishery. This was also considered to be the spatial extent for a potential redfish midwater trawl fishery for the purpose of this risk assessment.

Risk of the Redfish Midwater Trawl Fishery to the Conservation Priorities

a. Benthic habitats

The predicted redfish midwater trawl fishing area overlaps with approximately 30% of the site (primarily slope habitat; Figure 2.4.3-1), which resulted in a medium likelihood score. While the predicted fishery would occur primarily in areas of moderate natural disturbance, approximately 25% of the fishery is expected to overlap with areas of low natural disturbance (Figure 2.4.3-2).

Because midwater trawl gear only occasionally makes contact with the bottom, a very low consequence score was assigned. This resulted in an overall **low** risk from the redfish midwater trawl fishery to benthic habitats in the AOI (Table 2.4.4-2). There was a low level of certainty associated with this assessment because the location and extent of a modern redfish midwater trawl fishery is unknown.

Table 2.4.4 - 2. Risk of the redfish midwater trawl fishery to benthic habitats in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Sensitive benthic / structure forming species

Sensitive benthic / structure forming species are considered broadly distributed across the site. The predicted redfish midwater trawl area overlaps with most of the area identified as a soft coral important habitat and approximately half of the area identified as a sea pen concentration. As the

predicted redfish midwater trawl fishing area overlaps with approximately 30% of the AOI (Figure 2.4.3-3), a medium likelihood score was assigned. Because midwater trawl gear is expected to contact the bottom only infrequently, impacts to sensitive benthic /structure forming species should be rare, so the consequence score was determined to be low. This resulted in an overall risk score of **low** from the redfish midwater trawl fishery to sensitive benthic / structure forming species in the AOI (Table 2.4.4-3). There was a very low level of certainty associated with this assessment because of the limited available information on sensitive benthic / structure forming species distribution in the site, and because the location and extent of a modern redfish midwater trawl fishery is unknown.

Table 2.4.4 - 3. Risk of the redfish midwater trawl fishery to sensitive benthic / structure forming species in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Area of high fish diversity

The predicted redfish midwater trawl fishery overlaps with more than 50% of the area of high fish diversity (Figure 2.4.3-4), which resulted in a high likelihood score. From available observer data, the redfish midwater trawl fishery includes a considerable amount of bycatch. More than 40 different fish species were caught as bycatch in 81.41% of observed sets (Table 2.4.4-1), resulting in a high consequence score. The redfish midwater trawl fishery presents a **high** risk to the area of high fish diversity within the AOI (Table 2.4.4-4). There was a low level of certainty associated with this assessment based on the assumptions made to predict the fishing area for the redfish midwater trawl fishery and the limited available observer data.

Table 2.4.4 - 4. Risk of the redfish midwater trawl fishery to the area of high fish diversity in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

d. Atlantic cod

The predicted redfish midwater trawl fishing area overlaps with approximately 20% of important Atlantic cod habitat (Figure 2.4.3-5), resulting in a medium likelihood. Atlantic cod were found in approximately 65% of observer sets (Table 2.4.4-1), resulting in a high consequence score. The overall risk from the redfish midwater trawl fishery to Atlantic cod was considered to be **high** in the AOI (Table 2.4.4-5). There was a low level of certainty associated with this assessment based on the assumptions made to predict the fishing area for the redfish midwater

trawl fishery and the limited available observer data. It is important to note that the bycatch levels of Atlantic cod might be higher in the winter months as this area is an overwintering area and more cod would be present than in the summer months.

Table 2.4.4 - 5. Risk of the redfish midwater trawl fishery to Atlantic cod in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

e. Atlantic wolffish

The predicted redfish midwater trawl fishing area overlaps with less than 10% of the important Atlantic wolffish habitat (Figure 2.4.3-6), resulting in a low likelihood. While there were no records of Atlantic wolffish caught in the observer sets from 4Vn, Northern wolffish and wolffish (unspecified species) were reported in a total of 0.43% of sets (Table 2.4.4-1). Because wolffish species found in this area are presumed to be similarly susceptible to this gear type, it is postulated that <1% of catches might include Atlantic wolffish, so a low consequence score was assigned. The overall risk from the redfish midwater trawl fishery to Atlantic wolffish was considered to be **low** in the AOI (Table 2.4.4-6). There was a low level of certainty associated with this assessment based on the assumptions made to predict the fishing area for the redfish midwater trawl fishery and the limited available observer data.

Table 2.4.4 - 6. Risk of the redfish midwater trawl fishery to Atlantic wolffish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

f. Redfish

As outlined above for the redfish otter trawl assessment (Section 2.4.3h), redfish have been identified as a depleted species and conservation priority for the future St. Anns Bank MPA. Thus, an assessment of the risks presented by the redfish midwater trawl fishery to the redfish population in the AOI was conducted using the same method applied to other fisheries in the site.

The spatial overlap between the predicted redfish midwater trawl fishing area and the important redfish habitat was over 50% (Figure 2.4.3-7), resulting in a high likelihood. Redfish were caught in almost 100% of the observer sets for the redfish midwater trawl fishery (Table 2.4.4-1), resulting in a high consequence score. The overall risk from the redfish midwater trawl fishery to redfish was considered to be **high** in the AOI (Table 2.4.4-7). There was a moderate level of certainty associated with this assessment based on the assumptions made to predict the fishing area for the redfish midwater trawl fishery.

Table 2.4.4 - 7. Risk of the redfish midwater trawl fishery to redfish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

g. American plaice

There was no direct overlap between the predicted redfish midwater trawl fishery and habitat for American plaice (Figure 2.4.3-8). Thus, the likelihood score was determined to be very low. American plaice were found in less than 1% of observer sets in 4Vn (Table 2.4.4-1), resulting in a low consequence score. This resulted in an overall **very low** risk from the redfish midwater trawl fishery to American plaice in the AOI (Table 2.4.4-8). There was a low level of certainty associated with this assessment based on the assumptions made to predict the fishing area for the redfish midwater trawl fishery and the limited available observer data.

Table 2.4.4 - 8. Risk of the redfish midwater trawl fishery to American plaice in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

h. Leatherback turtles

The predicted redfish midwater trawl fishing area overlaps with 10-50% of the important habitat for leatherback turtle in the AOI (Figure 2.4.3-9), resulting in a medium likelihood. Leatherback turtle interactions with mobile gear are expected to be rare, and no interactions are known to have occurred off of Nova Scotia (DFO, 2012g). There is little information available on the impacts of midwater trawls on leatherback turtles, but for the purposes of this assessment, the consequence level is assumed to be the same as for otter trawl gear, which was assigned as low. The overall risk from the redfish midwater trawl fishery to leatherback turtles was considered to be **low** in the AOI (Table 2.4.4-9).

Table 2.4.4 - 9. Risk of the redfish midwater trawl fishery to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

There was a very low certainty score associated with this assessment due to the assumptions made to predict the fishing area for the redfish midwater trawl fishery, and the absence of

evidence of midwater trawl impacts on leatherback turtles. Note that the risk to leatherbacks would only be present when the leatherbacks are present in the AOI during summer foraging periods.

i. Benthic invertebrates

Benthic invertebrates were assumed to be widely distributed across the AOI, resulting in an overlap of approximately 30% with the predicted redfish midwater trawl fishing area and a likelihood score of medium. There were very few benthic invertebrate taxa found as bycatch in 1.28% of observed sets (Table 2.4.4-1), resulting in a low consequence score. The overall risk from the redfish midwater trawl fishery to benthic invertebrates was considered to be **low** in the AOI (Table 2.4.4-10). There was a low level of certainty associated with this assessment based on the assumptions made to predict the fishing area for the redfish midwater trawl fishery and the limited available observer data.

Table 2.4.4 - 10. Risk of the redfish midwater trawl fishery to benthic invertebrates in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

j. Forage fish

Forage fish were assumed to have a wide distribution across the entire AOI, resulting in an overlap of approximately 30% with the predicted redfish midwater trawl fishing area and a medium likelihood score. Mackerel were caught in 0.96% of observer sets, Atlantic herring and sand lance were caught in 1.50% and 10.36% of observer sets, respectively (Table 2.4.4-1). Altogether, forage fish as a group were caught in 12.82% of observer sets, resulting in a low consequence score. The overall risk from the redfish midwater trawl fishery to forage fish was considered to be **low** in the AOI (Table 2.4.4-11). There was a low level of certainty associated with this assessment based on the assumptions made to predict the fishing area for the redfish midwater trawl fishery, the limited available observer data, and the limited information on distribution and abundance of forage fish within the AOI.

Table 2.4.4 - 11. Risk of the redfish midwater trawl fishery to forage fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

k. Demersal fish

The predicted redfish midwater trawl fishing area overlapped the demersal fish habitat by approximately 25% (Figure 2.4.3-10), resulting in a medium likelihood score. In addition to

Atlantic cod, American plaice, Atlantic wolffish, and redfish (assessed above), 35 different demersal fish taxa were caught as bycatch in 70.94% of observed sets (Table 2.4.4-1), resulting in a high consequence score. The overall risk from the redfish midwater trawl fishery to demersal fish was determined to be **high** in the AOI (Table 2.4.4-12). There was a low level of certainty associated with this assessment based on the assumptions made to predict the fishing area for the redfish midwater trawl fishery, and the limited available observer data.

Table 2.4.4 - 12. Risk of the redfish midwater trawl fishery to demersal fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

l. Top predators

Sharks and marine mammals were assumed to have a broad distribution across the AOI, resulting in an approximately 30% overlap with the predicted redfish midwater trawl fishing area, and a medium likelihood score. The impacts of trawling gear on marine mammals are relatively unknown, however seals were caught in 0.75% of observer sets for midwater trawling (Table 2.4.4-1). Blue sharks were caught in 0.21% of sets, basking sharks in 0.11% of sets, and Greenland sharks in 0.11% of sets. Porbeagle sharks were found in 1.28% of observer sets (Table 2.4.4-1), and because they are considered by COSEWIC to be endangered, a medium consequence score was assigned, and the overall risk from the redfish midwater trawl fishery to top predators (sharks) was considered **medium** in the AOI (Table 2.4.4-13). There was a low level of certainty associated with this assessment based on the assumptions made to predict the fishing area for the redfish midwater trawl fishery, the limited observer data, and the limited information on the distribution and abundance of sharks in the site.

Table 2.4.4 - 13. Risk of the redfish midwater trawl fishery to top predators in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

<u>2.4.5 Halibut Longline</u>

Halibut are fished on the whole of the Scotian Shelf and the Grand Banks, mostly by longline using demersal hook and line gear, and the fishery occurs year round. They are generally fished along the edges of the continental shelf. The fishery was unregulated until 1988 when a total allowable catch was introduced. Overall, halibut biomass and recruitment have been increasing in the 2000s (DFO, 2011b). Halibut landings from within the AOI between 2000 and 2010 are shown in Table 2.4.5-1.

Table 2.4.5 - 1. Halibut landings in metric tonnes (mt) from the St. Anns Bank AOI (2000-2010).

Year	Weight (mt)
2000	2.64265
2001	4.865382
2002	4.784963
2003	4.238488
2004	9.456028
2005	4.513352
2006	5.231742
2007	5.021616
2008	2.689278
2009	8.506603
2010	3.672461

Observer data from 4Vn between 2000 and 2011 were used to characterize bycatch associated with the halibut longline fishery in the area (Table 2.4.5-2). There were a total of 11 observed trips and 61 sets in 4Vn between 2000 and 2011.

Table 2.4.5 - 2. Observer data for the halibut longline fishery in 4Vn from 2000-2011.

Species	# of sets	% of sets
Atlantic halibut	60	98.36
Atlantic cod	46	75.41
White hake	36	59.02
Thorny skate	29	47.54
Black dogfish	17	27.87
Turbot, Greenland halibut	14	22.95
Redfish (unseparated)	8	13.11
Hake	8	13.11
Spiny dogfish	6	9.84
Cusk	5	8.20
Haddock	4	6.56
Marlin-spike grenadier	4	6.56
Northern hagfish	3	4.92
Barndoor skate	3	4.92
Spotted wolffish	2	3.28
Northern wolffish	2	3.28
Winter skate	2	3.28
Atlantic wolffish	2	3.28
Porbeagle, mackerel shark	1	1.64
Snow crab (Queen)	1	1.64
Northern stone crab	1	1.64
All fish species (excluding halibut)	61	100
Benthic invertebrates	2	3.28
Demersal fish (non-depleted)	55	90.16

The spatial extent of the halibut longline fishery in the AOI was determined by the number of fishing sets as reported in fisheries logbooks from 1995-2011. Specifically, set locations were

binned into 2x2 minute grid cells (~10 km^2) and cells containing two or more sets were used to define the footprint of the fishery in the AOI (Figure 2.4.5-1). Included in these data are sets conducted as part of the sentinel survey, so the spatial extent of the fishery may be larger than the actual area fished for strictly commercial purposes.

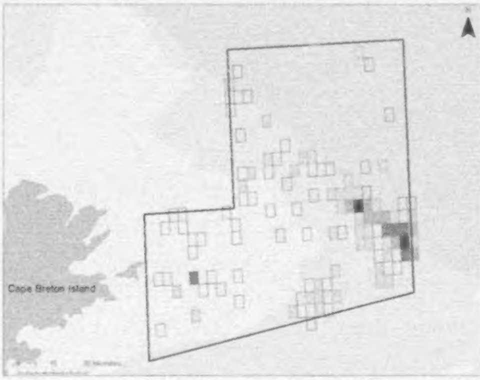

Figure 2.4.5 - 1. The total fishing extent (sum of all coloured grid cells) for the halibut longline fishery between 1995 and 2011 in the AOI was approximately 500 km^2. Grid cells containing only one recorded set were not included as part of the fishing footprint.

Risk of the Halibut Longline Fishery to the Conservation Priorities

a. Benthic habitats

The spatial extent of the halibut bottom longline fishery covers less than 10% of the AOI (Figure 2.4.5-1), resulting in a low likelihood.

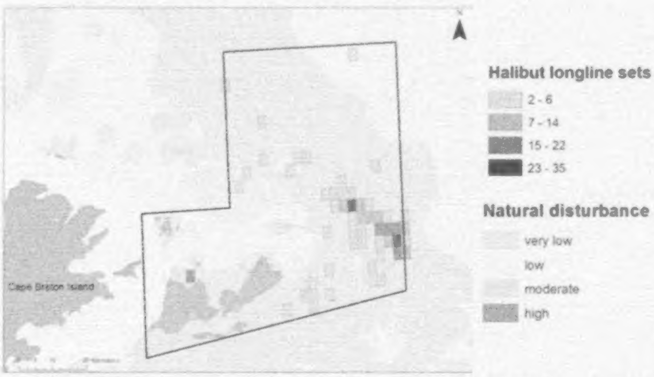

Figure 2.4.5 - 2. The spatial overlap between the halibut longline fishery the levels of natural disturbance (modified from Ford and Serdynska, 2013) in benthic habitats within the St. Anns Bank AOI (black polygon).

Because fishing activity was focused within areas of moderate to high natural disturbance (Figure 2.4.5-2), the consequence was considered to be low, and the overall risk from the halibut longline fishery to benthic habitats was determined to be **low** in the AOI (Table 2.4.5-3). There was a moderate level of certainty associated with this assessment based on available fisheries data and known impacts of this gear type on benthic habitats.

Table 2.4.5 - 3. Risk of the halibut longline fishery to benthic habitats in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Sensitive benthic / structure forming species

The sensitive benthic and structure forming species are presumed to be broadly distributed across the site (Figure 2.4.5-3). Because the fishing footprint covers less than 10% of the site, a low likelihood score was assigned.

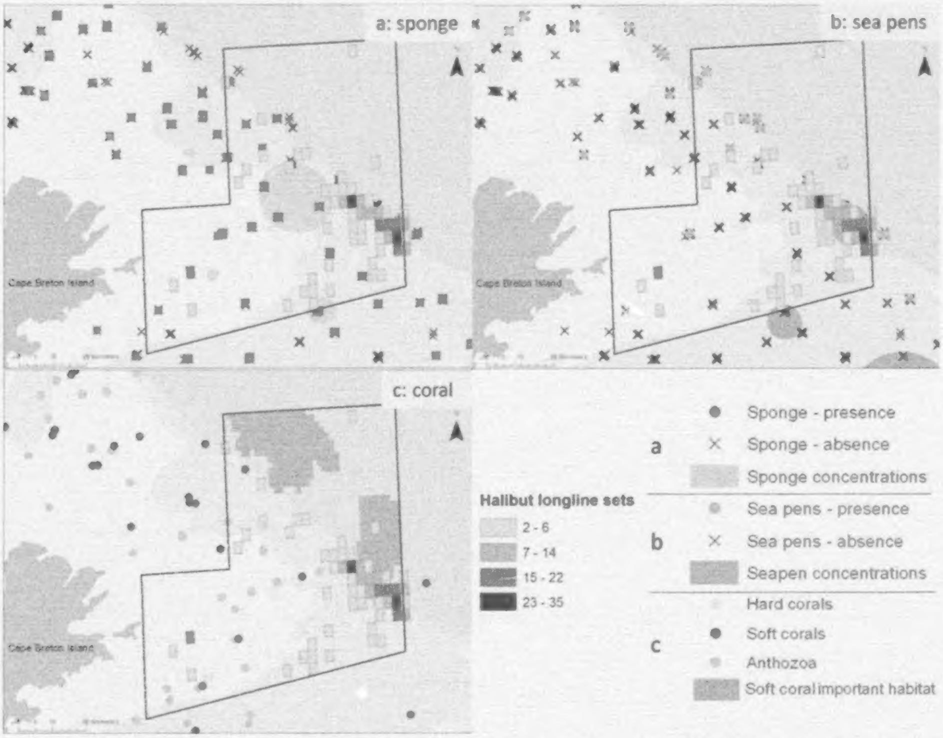

Figure 2.4.5 - 3. The spatial overlap between the halibut longline fishery and a) locations of sponge presence and absence from the RV survey and the sponge concentrations (modified from Kenchington et al. 2010), b) locations of sea pen presence and absence from the RV survey and the sea pen concentrations (modified from Kenchington et al. 2010), c) locations of different coral types and the soft coral important habitat in and around the St. Anns Bank AOI (black polygon).

Although bottom-contacting fixed gears such as demersal longline are much less damaging than bottom-contacting mobile gears, this gear type does have the potential to displace or remove coral and sponge individuals or colonies, particularly in rough oceanographic conditions when the gear is dragged along the seafloor (DFO, 2010c). As well, the halibut longline fishery

overlaps with the majority of the sea pen concentration and some of the soft coral important habitat. As such, a medium consequence score was assigned. This resulted in an overall **low** risk from the halibut longline fishery to sensitive benthic /structure forming species in the AOI (Table 2.4.5-4). There was a low level of certainty associated with this assessment based on the limited information on the distribution of sensitive benthic / structure forming species in the AOI.

Table 2.4.5 - 4. Risk of the halibut longline fishery to sensitive benthic / structure forming species in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Area of high fish diversity

The halibut longline fishery overlaps with approximately 25% of the area of high fish diversity (Figure 2.4.5-4), resulting in a medium likelihood score. There were a total of 17 fish species caught as bycatch in 100% of the observed sets for the halibut longline fishery (Table 2.4.5-2) resulting in a high consequence score. The overall risk of the halibut longline fishery to the area of high fish diversity was determined to be **high** in the AOI (Table 2.4.5-5). There was a moderate level of certainty associated with this risk score based on available fisheries data.

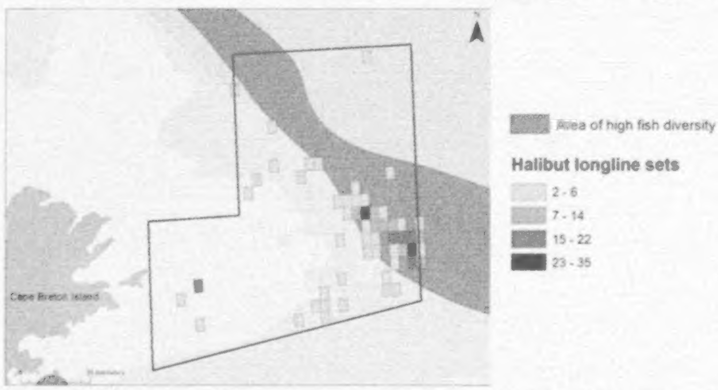

Figure 2.4.5 - 4. The spatial overlap between the halibut longline fishery and the area of high fish diversity (modified from Ford and Serdynska, 2013) within the St. Anns Bank AOI (black polygon).

Table 2.4.5 - 5. Risk of the halibut longline fishery to the area of high fish diversity in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

d. Atlantic cod

The halibut longline fishery overlaps with just over 10% of important cod habitat (Figure 2.4.5-5), resulting in a medium likelihood score. Atlantic cod were reported in over 75% of observed sets (Table 2.4.5-2), resulting in a high consequence score. Taken together, the overall risk from the halibut longline fishery to Atlantic cod in the AOI was determined to be **high** in the AOI (Table 2.4.5-6). There was a moderate level of certainty associated with this risk score based on available fisheries data.

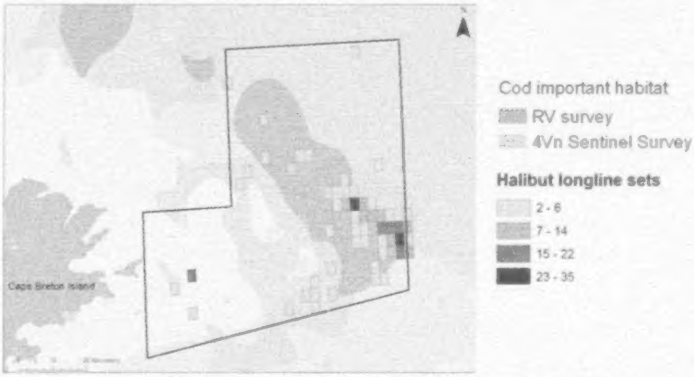

Figure 2.4.5 - 5. The spatial overlap between the halibut longline fishery and important Atlantic cod habitat in and around the St. Anns Bank AOI (black polygon), identified using the RV survey (Horsman and Shackell, 2009) and the sentinel survey.

Table 2.4.5 - 6. Risk of the halibut longline fishery to Atlantic cod in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

e. Atlantic wolffish

The halibut longline fishery overlaps with between 10 and 50% of the important Atlantic wolffish habitat (Figure 2.4.5-6), resulting in a medium likelihood score. Atlantic wolffish were found in just over 3% of observed sets (Table 2.4.5-2), which resulted in a medium consequence score. The overall risk from the halibut longline fishery to Atlantic wolffish was determined to be **medium** in the AOI (Table 2.4.5-7). There was a moderate level of certainty associated with this risk score based on available fisheries data.

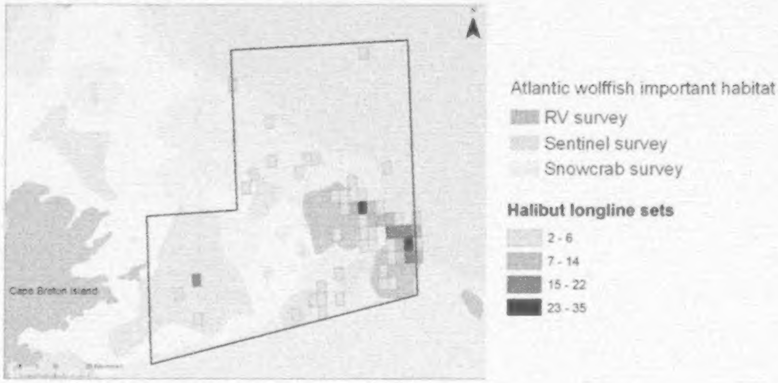

Figure 2.4.5 - 6. The spatial overlap between the halibut longline fishery and important Atlantic wolffish habitat in and around the St. Anns Bank AOI (black polygon), identified through the RV survey (Horsman and Shackell 2009), and the sentinel and snow crab surveys.

Table 2.4.5 - 7. Risk of the halibut longline fishery to Atlantic wolffish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

f. Redfish

The halibut longline fishery overlaps with less than 10% of the important redfish habitat (Figure 2.4.5-7), resulting in a low likelihood score. Redfish were found in over 13% of the observer sets (Table 2.4.5-2), which results in a high consequence score. The overall risk from the halibut longline fishery to redfish was determined to be **medium** in the AOI (Table 2.4.5-8). There was a moderate level of certainty associated with this risk score based on available fisheries data.

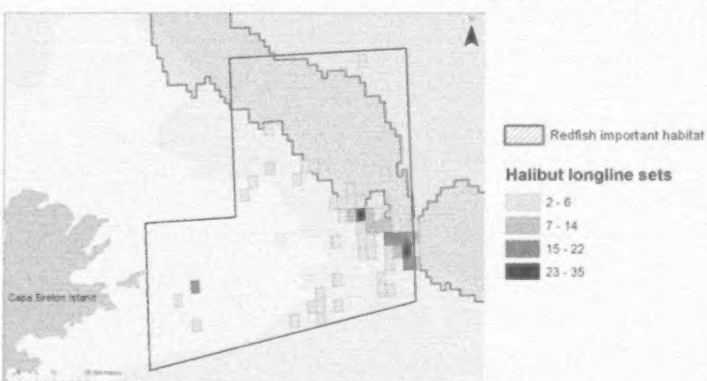

Figure 2.4.5 - 7. The spatial overlap between the halibut longline fishery and important redfish habitat within the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Table 2.4.5 - 8. Risk of the halibut longline fishery to redfish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

g. Leatherback turtles

The halibut longline fishery overlaps with less than 10% of the important leatherback turtle habitat in the AOI (Figure 2.4.5-8), resulting in a low likelihood score. While there is much concern regarding the potential impacts of pelagic longline fishing gear on leatherback turtles (Lewison et al., 2004), the halibut fishery uses bottom-contacting gear with minimal floating components, so the entanglement potential is more limited. While no leatherback interactions with this gear type have been reported in the region to date, there is still the possibility of entanglement with this gear type (DFO, 2012g). Thus, the consequence score was determined to be low. The overall risk from the halibut longline fishery to leatherback turtles during the summer foraging season was determined to be **low** in the AOI (Table 2.5.4-9). There was a low level of certainty associated with this assessment based on the limited observer coverage in the AOI. Note that the risk to leatherbacks would only be present when the turtles are in the AOI during summer foraging periods.

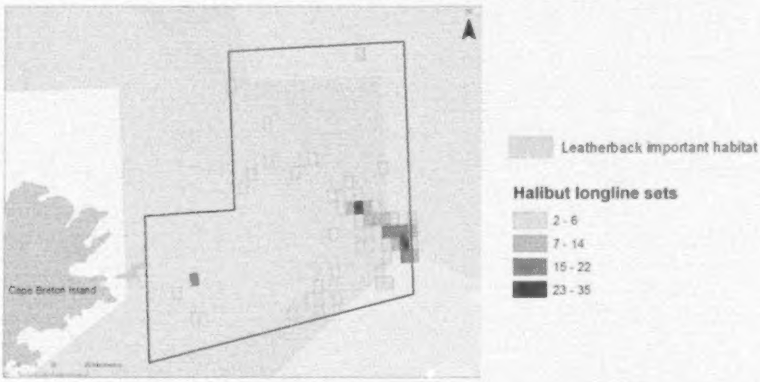

Figure 2.4.5 - 8. The spatial overlap between the halibut longline fishery and important habitat for leatherback turtles (modified from DFO, 2012f) in the St. Anns Bank AOI (black polygon).

Table 2.4.5 - 9. Risk of the halibut longline fishery to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

i. Benthic invertebrates

Benthic invertebrates are assumed to be widely distributed across the site. Because the halibut longline fishery overlaps with less than 10% of the AOI, a low likelihood score was assigned. Halibut longline gear has the potential to damage or crush benthic invertebrate species, particularly in rough oceanographic conditions when the gear can be dragged along the seafloor (DFO, 2010c), resulting in a medium consequence. Altogether, the risk from the halibut longline fishery to benthic invertebrates was determined to be **low** in the AOI (Table 2.4.5-10). There was a moderate level of certainty associated with this risk score based on available fisheries data.

Table 2.4.5 - 10. Risk of the halibut longline fishery to benthic invertebrates in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

j. Demersal fish

The halibut longline fishery overlaps with approximately 11% of demersal fish habitat (Figure 2.4.5-9), resulting in a medium likelihood score. In addition to Atlantic cod, redfish, American plaice, and Atlantic wolffish (assessed above), available Observer data also reported 14 species of demersal fish in 90.16% of sets (Table 2.4.5-2), resulting in a high consequence score. The overall risk from the halibut longline fishery to demersal fish was determined to be **high** in the AOI (Table 2.4.5-11). There was a moderate level of certainty associated with this risk score based on available fisheries data.

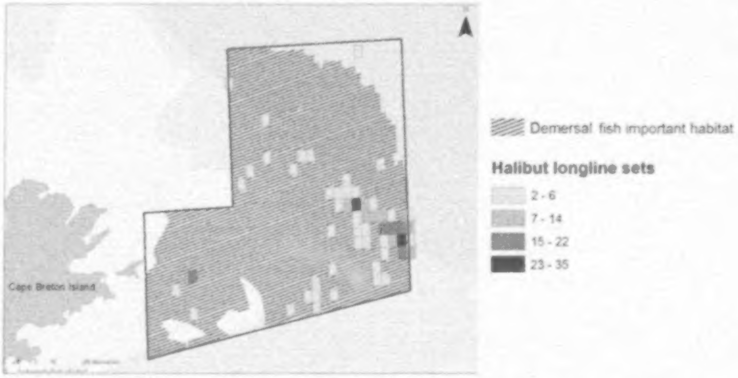

Figure 2.4.5 - 9. The spatial overlap between the halibut longline fishery and important habitat for demersal fish in the St. Anns Bank AOI (black polygon).

Table 2.4.5 - 11. Risk of the halibut longline fishery to demersal fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

m. Top predators (sharks)

Sharks are assumed to have a wide distribution across the AOI. As the halibut longline fishing footprint covers less than 10% of the site, a low likelihood score was assigned. Porbeagle sharks were found in 1.64% of observed sets (Table 2.4.5-2) and because they are endangered, a medium consequence score was assigned. Overall the halibut longline fishery was determined to present a **low** risk to sharks in the AOI (Table 2.4.5-12). While available fisheries data is generally adequate, a low level of certainty should be associated with this assessment based on the limited information on distribution and abundance of sharks in the site.

Table 2.4.5 - 12. Risk of the halibut longline fishery to top predators (sharks) in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

2.4.6 Herring Roe Gillnet Fishery

There is a small fall (September-October) inshore herring roe gillnet fishery in Glace Bay, and in the Big Shoal Spawning area in northwest corner of the AOI, though catches have dropped in St. Anns Bank in recent years (Power et al., 2010). The spatial extent of the commercial herring fishery in the AOI was determined by the number of fishing sets as reported in fisheries logbooks between 1995 and 2011. Set locations were binned into 2x2 minute grid cells (~10 km^2) grid cells and cells containing two or more sets were used to define the footprint of the fishery in the AOI (Figure 2.4.6-1).

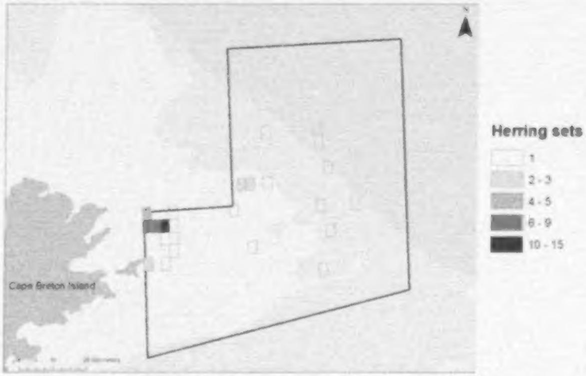

Figure 2.4.6 - 1. The spatial extent of the herring gillnet fishery within the AOI (black polygon). Grid cells containing only one recorded set were not included as part of the fishing footprint.

Table 2.4.6 - 1. Herring landings in metric tonnes (mt) caught within the St. Anns Bank AOI from 2000 to 2008.

Year	Herring (mt)
2000	98.94
2001	98.43
2002	-
2003	80.08
2004	19.50
2005	-
2006	-
2007	-
2008	3.36

There were no records from the At-Sea Observer program to help characterize bycatch in the herring gillnet fishery. However, because the commercial herring roe gillnet fishery uses a net with a very small mesh size and the nets are not left unattended, little to no bycatch or entanglement is expected for this fishery in the St. Anns Bank area (Rabindra Singh, personal communication). As such, for the purpose of this assessment, consequence scores for conservation priorities that rely upon bycatch profiles were considered low for this fishery.

Risk of the Herring Roe Gillnet Fishery to Conservation Priorities

a. Area of high fish diversity

There is no overlap between the herring fishery and the area of high fish diversity (Figure 2.4.6-2), resulting in a very low likelihood score. Based on the assumption that there is little to no bycatch in this fishery, the consequence score was considered to be low. This resulted in an overall **very low** risk from the herring gillnet fishery to fish diversity in the AOI (Table 2.4.6-2). There was a very low level of certainty associated with this assessment due to the limited available fisheries logbook data and absence of At-Sea Observer program data for the fishery in this area.

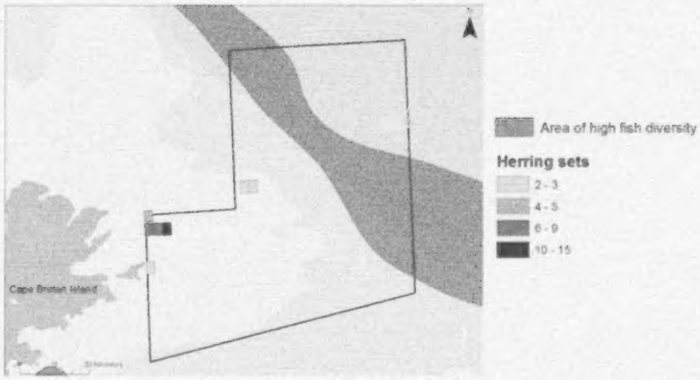

Figure 2.4.6 - 2. The spatial overlap between the herring roe gillnet fishery and the area of high fish diversity (modified from Ford and Serdynska, 2013) within the St. Anns Bank AOI (black polygon).

Table 2.4.6 - 2. Risk of the herring roe gillnet fishery to the area of high fish diversity in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Atlantic cod

The herring roe gillnet fishery overlaps with less than 1% of the important Atlantic cod habitat (Figure 2.4.6-3), resulting in a very low likelihood.

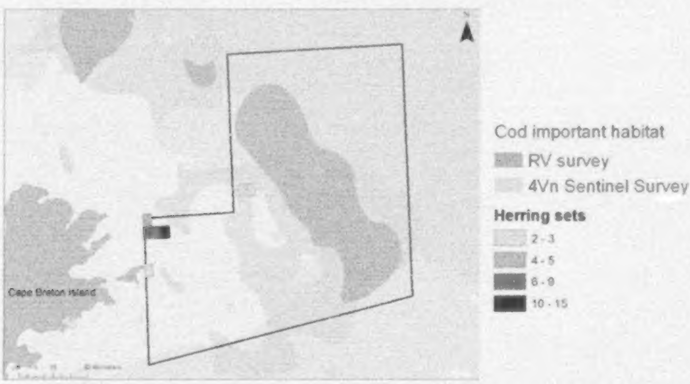

Figure 2.4.6 - 3. The spatial overlap between the herring roe gillnet fishery and important Atlantic cod habitat in the St. Anns Bank AOI (black polygon), identified using the RV survey (Horsman and Shackell, 2009) and the sentinel survey.

Based on the assumption that there is little to no bycatch in this fishery, the consequence score was considered to be low. This resulted in a **very low** risk from the herring roe gillnet fishery to

Atlantic cod in the AOI (Table 2.4.6-3). There was a very low level of certainty associated with this assessment due to the limited available fisheries logbook data and absence of At-Sea Observer program data for the fishery in this area.

Table 2.4.6 - 3. Risk of the herring roe gillnet fishery to Atlantic cod in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Atlantic wolffish

The herring gillnet fishery overlaps with approximately 1.2% of the important Atlantic wolffish habitat (Figure 2.4.6-4), resulting in a low likelihood score. Based on the assumption that there is little to no bycatch in this fishery, the consequence score was considered to be low. This resulted in an overall **low** risk from the herring gillnet fishery to Atlantic wolffish in the AOI (Table 2.4.6-4). There was a very low level of certainty associated with this assessment due to the limited available fisheries logbook data and absence of At-Sea Observer program data for the fishery in this area.

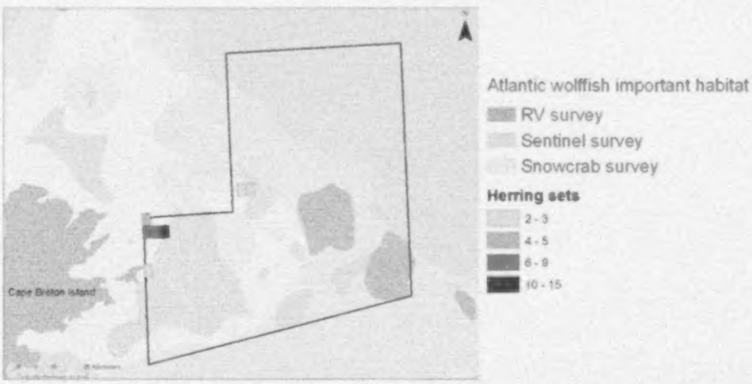

Figure 2.4.6 - 4. The spatial overlap between the herring roe gillnet fishery and important Atlantic wolffish habitat in the St. Anns Bank AOI (black polygon), identified through the RV survey (Horsman and Shackell, 2009), and the sentinel and snow crab surveys.

Table 2.4.6 - 4. Risk of the herring roe gillnet fishery to Atlantic wolffish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

d. Redfish

There is no overlap between the herring roe gillnet fishery and the area identified as important habitat for redfish (Figure 2.4.6-5), resulting in a very low likelihood score. Based on the assumption that there is little to no bycatch in this fishery, the consequence score was assigned as low. This resulted in an overall **very low** risk from the herring roe gillnet fishery to redfish in the AOI (Table 2.4.6-5). There was a very low level of certainty associated with this assessment due to the limited available fisheries logbook data and absence of At-Sea Observer program data for the fishery in this area.

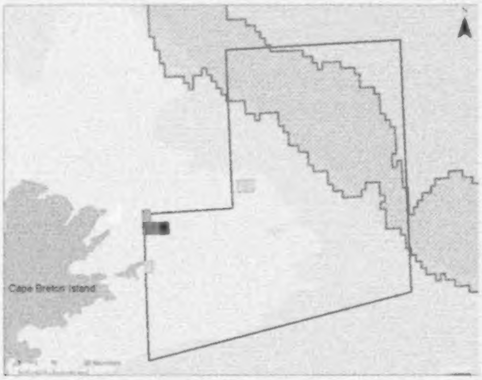

Figure 2.4.6 - 5. The spatial overlap between the herring roe gillnet fishery and important redfish habitat within the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Table 2.4.6 - 5. Risk of the herring roe gillnet fishery to redfish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

e. American plaice

The herring fishery overlaps with approximately 1.5% of the important American plaice habitat (Figure 2.4.6-6), resulting in a low likelihood. Based on the assumption that there is little to no bycatch in the herring roe gillnet fishery, the consequence score was assigned as low. This resulted in an overall **low** risk from the herring roe gillnet fishery to American plaice in the AOI (Table 2.4.6-6). There was a very low level of certainty associated with this assessment due to the limited available fisheries logbook data and absence of At-Sea Observer program data for the fishery in this area.

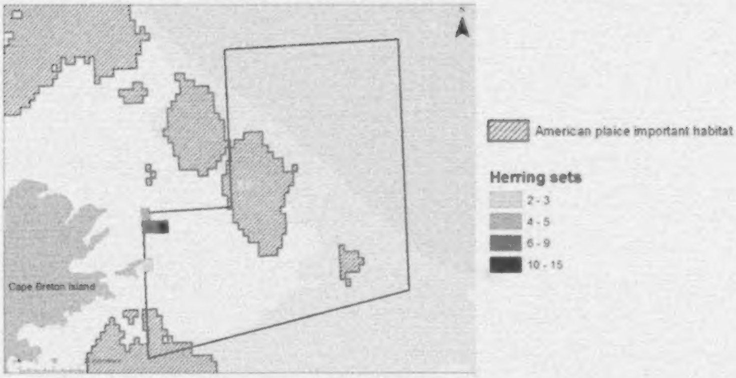

Figure 2.4.6 - 6. The spatial overlap between the herring roe gillnet fishery and important habitat for American plaice in the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Table 2.4.6 - 6. Risk of the herring roe gillnet fishery to American plaice in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

f. Leatherback turtles

The herring roe gillnet fishery overlaps with approximately 1.6% of the important habitat for leatherback turtles in the AOI (Figure 2.4.6-7), resulting in a low likelihood.

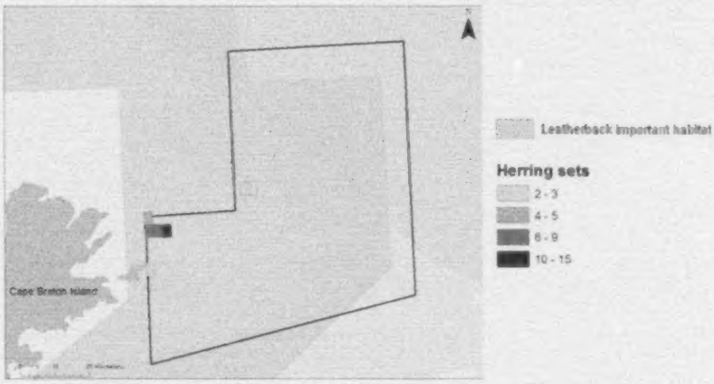

Figure 2.4.6 - 7. The spatial overlap between the herring roe gillnet fishery important habitat for leatherback turtles (modified from DFO, 2012f) in the St. Anns Bank AOI (black polygon).

Leatherbacks can become entangled in gillnet fishing gear (Baer et al., 2010; James et al., 2005). Although this fishery would occur at the time of year when turtles are in the area, the gear is not left unattended in the herring roe fishery, so the consequence score was determined to be low. This resulted in an overall **low** risk from the herring roe gillnet fishery to leatherback turtles in

the AOI (Table 2.4.6-7). There was a low level of certainty associated with this assessment due to the limited available fisheries logbook data.

Table 2.4.6 - 7. Risk of the herring roe gillnet fishery to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

g. Forage fish

The target of the herring roe fishery is a forage fish. However, because this fishery is managed by DFO and herring was not identified as a specific conservation priority for the site, other forage fish species that make up this functional group were the focus of this risk assessment. Forage fish are assumed to have a wide distribution across the AOI, resulting in an approximately 1.4% habitat overlap and a low likelihood score. Based on the assumption that there is little to no bycatch in this gillnet-based fishery, the consequence score was assigned as low. This resulted in an overall **low** risk of the herring roe gillnet fishery to forage fish in the AOI (Table 2.4.6-8). There was a very low level of certainty associated with this assessment due to the limited available fisheries logbook data and absence of At-Sea Observer program data for the fishery in this area.

Table 2.4.6 - 8. Risk of the herring roe gillnet fishery to forage fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

h. Demersal fish

The herring roe gillnet fishery overlaps with less than 1% of the demersal fish important habitat (Figure 2.4.6-9), resulting in a very low likelihood score. Under the assumption that there is little to no bycatch in the herring roe gillnet fishery, the consequence score was considered to be low. This resulted in an overall **very low** level of risk from the herring roe gillnet fishery to demersal fish in the AOI (Table 2.4.6-9). There was a very low level of certainty associated with this assessment due to the limited available fisheries logbook data and absence of At-Sea Observer program data for the fishery in this area.

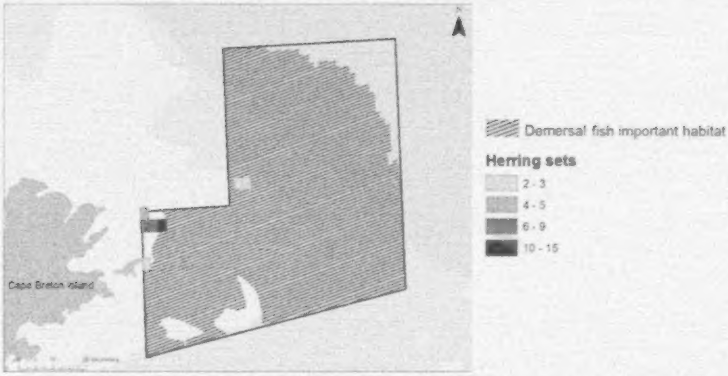

Figure 2.4.6 - 8. The spatial overlap between the herring roe gillnet fishery and important habitat for demersal fish in the St. Anns Bank AOI (black polygon).

Table 2.4.6 - 9. Risk of the herring roe gillnet fishery to demersal fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

i. Top predators

Top predators are assumed to have a wide distribution across the AOI, resulting in an approximately 1.4% overlap with the herring roe gillnet fishery and a low likelihood score. Many top predators are pelagic species that are known to be vulnerable to mortality from pelagic gillnets. Sharks, seals, seabirds, whales, and harbour porpoises are known to get entangled in floating gillnets (Baer et al., 2010; Lesage et al., 2003). However, because the gear is not left unattended in the herring roe fishery, the consequence score was determined to be low. The overall risk from the herring gillnet fishery to top predators was assigned as **low** in the AOI (Table 2.4.6-10). There was a very low level of certainty associated with this assessment based on the lack of available bycatch information from this fishery.

Table 2.4.6 - 10. Risk of the herring gillnet fishery to top predators in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

2.4.7 Gillnet Bait Fishery

Catch information from the gillnet bait fishery for herring and mackerel in the St. Anns Bank area is extremely limited. This is due in part to the low level of effort in this fishery, and also to

poor compliance with reporting requirements. No data on mackerel landings in the area are available after 2001, and available data on herring landings are presumed to be mostly from the herring roe fishery in the area (see Table 2.4.6-1). Information gathered from local knowledge holders (including the fishery manager, a local fishery officer, and a DFO scientist with expertise on small pelagic fisheries in the area) indicates that the bait fishery in the area is generally conducted near to shore (i.e., up to ~ 3 km out from Scatarie Island; Figure 2.4.7-1) with mid-water to surface gillnets, the target species is mackerel, and the active fishing season occurs primarily in the summer months (June to mid-August).

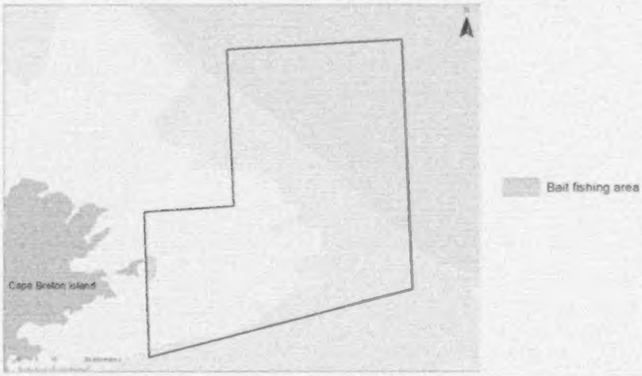

Figure 2.4.7 - 1. The spatial extent of the gillnet bait fishery within the AOI (black polygon).

No observer data is available to characterize bycatch for the gillnet bait fishery in the area. However, the gear used in this fishery is considered fairly selective for mackerel, with only occasional catches of perch, pollock, cod or herring (Scott Phillips, Fishery Officer, personal communication). Thus, for the purpose of this assessment, consequence scores for conservation priorities that rely upon bycatch profiles were considered low for this fishery. In contrast, these nets are typically left in the water for the duration of the season, and are only checked on a daily basis (Scott Phillips, personal communication). As such, entanglements may occur.

Risk of the Gillnet Bait Fishery to Conservation Priorities

a. Area of high fish diversity

There is no overlap between the gillnet bait fishery and the area of high fish diversity (Figure 2.4.7-2), resulting in a very low likelihood score. Based on the assumption that there is limited bycatch in this fishery, the consequence score was considered to be low. This resulted in an overall **very low** risk from the gillnet bait fishery to fish diversity in the AOI (Table 2.4.7-1). There was a very low level of certainty associated with this assessment due to the lack of available data for this fishery.

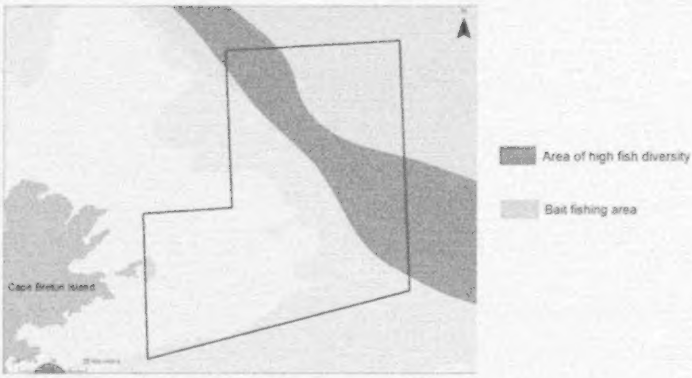

Figure 2.4.7 - 2. The spatial overlap between the gillnet bait fishery and the area of high fish diversity (modified from Ford and Serdynska, 2013) within the St. Anns Bank AOI (black polygon).

Table 2.4.7 - 1. Risk of the gillnet bait fishery to the area of high fish diversity in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Atlantic cod

The gillnet bait fishery does not overlap with the important Atlantic cod habitat (Figure 2.4.7-3), resulting in a very low likelihood. Based on the assumption that there is limited bycatch in this fishery, the consequence score was considered to be low. This resulted in a **very low** risk from the gillnet bait fishery to Atlantic cod in the AOI (Table 2.4.7-2). There was a very low level of certainty associated with this assessment due to the lack of available data for this fishery.

Figure 2.4.7 - 3. The spatial overlap between the gillnet bait fishery and important Atlantic cod habitat in the St. Anns Bank AOI (black polygon), identified using the RV survey (Horsman and Shackell, 2009) and the sentinel survey.

Table 2.4.7 - 2. Risk of the gillnet bait fishery to Atlantic cod in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Atlantic wolffish

The gillnet bait fishery overlaps with less than 1% of the important Atlantic wolffish habitat (Figure 2.4.7-4), resulting in a very low likelihood score. Based on the assumption that there is limited bycatch in this fishery, the consequence score was considered to be low. This resulted in an overall **very low** risk from the gillnet bait fishery to Atlantic wolffish in the AOI (Table 2.4.7-3). There was a very low level of certainty associated with this assessment due to the lack of available data for this fishery.

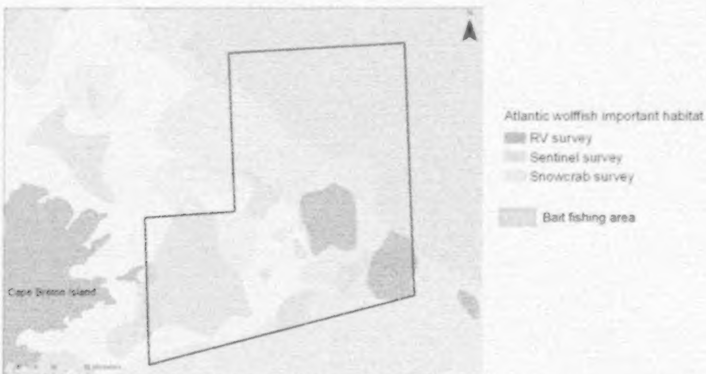

Figure 2.4.7 - 4. The spatial overlap between the gillnet bait fishery and important Atlantic wolffish habitat in the St. Anns Bank AOI (black polygon), identified through the RV survey (Horsman and Shackell, 2009), and the sentinel and snow crab surveys.

Table 2.4.7 - 3. Risk of the gillnet bait fishery to Atlantic wolffish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

d. Redfish

There is no overlap between the gillnet bait fishery and the area identified as important habitat for redfish (Figure 2.4.7-5), resulting in a very low likelihood score. Based on the assumption that there is limited bycatch in this fishery, the consequence score was assigned as low. This resulted in an overall **very low** risk from the gillnet bait fishery to redfish in the AOI (Table

2.4.7-4). There was a very low level of certainty associated with this assessment due to the lack of available data for this fishery.

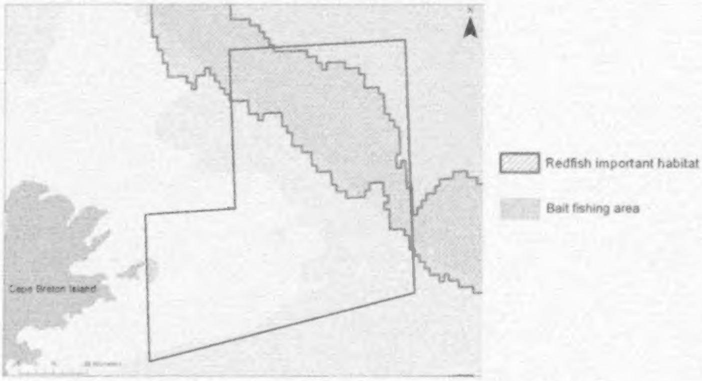

Figure 2.4.7 - 5. The spatial overlap between the gillnet bait fishery and important redfish habitat within the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Table 2.4.7 - 4. Risk of the gillnet bait fishery to redfish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

e. American plaice

There is no overlap between the gillnet bait fishery and the important American plaice habitat (Figure 2.4.7-6), resulting in a very low likelihood score.

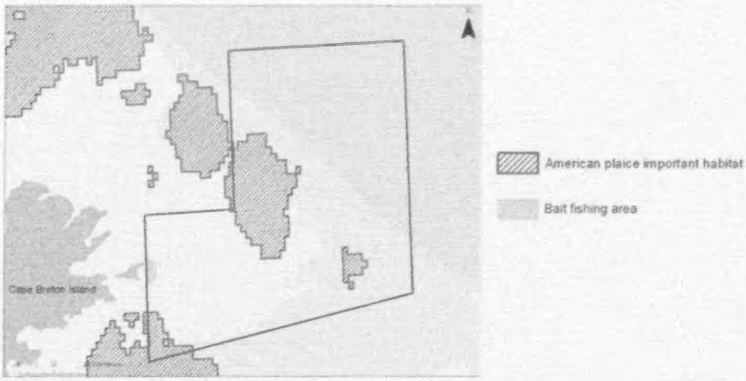

Figure 2.4.7 - 6. The spatial overlap between the gillnet bait fishery and important habitat for American plaice in the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Based on the assumption that there is limited bycatch in this fishery, the consequence score was assigned as low. This resulted in an overall **very low** risk from the gillnet bait fishery to American plaice in the AOI (Table 2.4.7-5). There was a very low level of certainty associated with this assessment due to the lack of available data for this fishery.

Table 2.4.7 - 5. Risk of the gillnet bait fishery to American plaice in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

f. Leatherback turtles

The gillnet bait fishery overlaps with approximately 0.44% of the important habitat for leatherback turtles in the AOI (Figure 2.4.7-7), resulting in a very low likelihood score. Leatherback turtles are known to become entangled in gillnet fishing gear (Baer et al., 2010; James et al., 2005). Bait gillnets are left unattended for ~24 hours at a time in the AOI (Scott Phillips, personal communication), allowing ample time for entanglement to occur. Because the active season for the gillnet bait fishery coincides with the time of year when turtles are present, the consequence score was determined to be high. This resulted in an overall **low** risk from the gillnet bait fishery to leatherback turtles in the AOI (Table 2.4.7-6). There was a very low level of certainty associated with this assessment due to the lack of available data for this fishery.

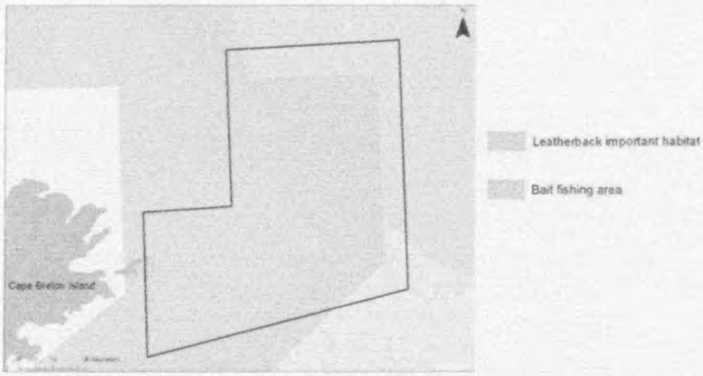

Figure 2.4.7 - 7. The spatial overlap between the gillnet bait fishery and important habitat for leatherback turtles (modified from DFO, 2012f) in the St. Anns Bank AOI (black polygon).

Table 2.4.7 - 6. Risk of the gillnet bait fishery to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

g. Forage fish

Herring and mackerel are forage fish, and are the targets of the gillnet bait fishery. However, because the fishery is managed by DFO and herring and mackerel have not been identified as specific conservation priorities for the site, other forage fish species that make up this functional group (e.g., capelin) were the focus of this risk assessment.

Forage fish are assumed to have a wide distribution across the AOI, resulting in an approximately 0.36% overlap with the gillnet bait fishery and a very low likelihood score. Based on the assumption that there is limited bycatch in this fishery, the consequence score was assigned as low. This resulted in an overall **very low** risk of the gillnet bait fishery to forage fish in the AOI (Table 2.4.7-7). There was a very low level of certainty associated with this assessment due to the lack of available data for this fishery.

Table 2.4.7 - 7. Risk of the gillnet bait fishery to forage fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

h. Demersal fish

The gillnet bait fishery overlaps with less than 1% of the demersal fish important habitat (Figure 2.4.7-8), resulting in a very low likelihood score. Under the assumption that there is limited bycatch in this fishery, the consequence score was considered to be low. This resulted in an overall **very low** level of risk from the gillnet bait fishery to demersal fish in the AOI (Table 2.4.7-8). There was a very low level of certainty associated with this assessment due to the lack of available data for this fishery.

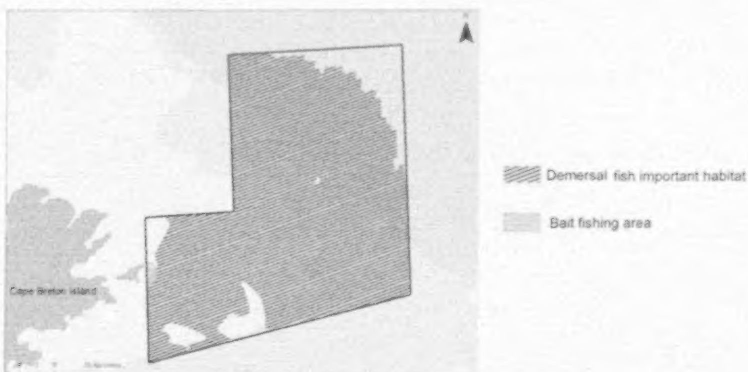

Figure 2.4.7 - 8. The spatial overlap between the gillnet bait fishery and important habitat for demersal fish in the St. Anns Bank AOI (black polygon).

Table 2.4.7 - 8. Risk of the gillnet bait fishery to demersal fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

i. Top predators

Top predators are assumed to have a wide distribution across the AOI, resulting in an approximately 0.36% overlap with the gillnet bait fishery and a very low likelihood score. Sharks, seals, seabirds, whales, and harbour porpoises are susceptible to entanglement in floating gillnets (Baer et al., 2010; Lesage et al., 2003). A Newfoundland and Labrador study reported 7 humpback whale entanglements have occurred in gillnet gear since 1995 (Benjamins et al., 2012), and another study reported entanglement of 2 right whales and 11 humpback whales from the northwest Atlantic (Johnson et al. 2005), therefore the consequence score was determined to be high. The overall risk from the gillnet bait fishery to top predators was assigned as **low** in the AOI (Table 2.4.7-9). There was a very low level of certainty associated with this assessment due to the lack of available data for this fishery.

Table 2.4.7 - 9. Risk of the gillnet bait fishery to top predators in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

2.4.8 Whelk Pot Fishery

There is currently no commercial fishery for whelk in the AOI, however there has been some limited experimental and exploratory fishing activity within St. Anns Bank in recent years. The fishery has taken place in the fall (late August to early December) and uses a string of up to 30 Newfoundland traps with a mesh covering of 1.9 cm in diameter and an entry hole of 2.35 cm (Rawlings et al., 2009). To date, there have only been two experimental fishing areas in the AOI: one area to the north and the other area to the south of Scatarie Island. There was also some exploratory fishing conducted in the south west section of the AOI in 2012. In the experimental fishery, whelk pots that were deployed within the St. Anns Bank AOI resulted in the catch of over 4000 whelk in 2008 (Rawlings et al., 2009).

The spatial extent of the proposed whelk fishery was determined by binning experimental set locations from Rawlings et al., (2009) and catch and effort data from Maritimes fisheries logbooks into 2x2 minute grid cells (~10 km^2). Due to the extremely limited data for this fishery, the footprint of the proposed fishery was defined as areas within which one or more experimental or exploratory set(s) was fished. The fishing sets occurred in depths of less than 100 metres. A

map depicting the fishing area could not be shown to protect confidentiality due to the small number of participants in this fishery.

Bycatch for this experimental fishery was recorded by onboard observers as part of data collection for the study. A total of 12 sets were observed for bycatch in 4Vn (Rawlings et al., 2009; Table 2.4.8-1). Species were recorded as presence or absence in each set.

Table 2.4.8 - 1. Observed bycatch data for 12 sets of the experimental whelk fishery in 4Vn from the fall of 2008 (Rawlings et al., 2009).

Species	# of sets	% of sets
Toad crab	8	66.67
Sculpin	8	66.67
Sea star	7	58.33
Hermit crab	6	50.00
Brittle star	5	41.67
Lobster	4	33.33
Rock crab	4	33.33
Urchin	4	33.33
Other snails	3	25.00
Shrimp	2	16.67
Wolffish	2	16.67
Basket star	2	16.67
Snow crab	1	8.33
Eel pout	1	8.33
Cod	1	8.33
Silver hake	1	8.33
Sand dollar	1	8.33
Sea cucumber	1	8.33
All fish species	8	66.67
Benthic invertebrates (excluding whelk)	12	100
Demersal fish (non-depleted)	8	66.67

Risk of the Whelk Pot Fishery to Conservation Priorities

a. Benthic habitats

The spatial extent of the whelk pot fishery overlaps with approximately 2.4% of the AOI, resulting in a low likelihood. Whelk pots are a fixed benthic gear. Where natural disturbance data are available, the fishery occurs in areas of high natural disturbance, resulting in a low consequence score. This resulted in an overall **low** risk from the whelk pot fishery to benthic habitats in the AOI (Table 2.4.8-2). There was a very low level of certainty associated with this assessment based on the absence of natural disturbance information near shore and the unknown extent of the hypothetical commercial whelk fishery in the site.

Table 2.4.8 - 2. Risk of the whelk pot fishery to benthic habitats in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Sensitive benthic / structure forming species

Sponges, corals and sea pens are considered to be widely distributed across the AOI. The spatial extent of the experimental whelk pot fishery is approximately 2.4% of the site, with no overlap with the areas identified as important habitat for sensitive benthic species. Thus, a low likelihood score was assigned. Bottom-contacting fixed gear may crush or entangle sensitive benthic / structure forming species, and damage can also occur if traps are dragged across the seafloor in strong currents (DFO, 2010c). Similar to the lobster and snow crab fisheries, damage can occasionally occur with whelk traps, so the consequence level was considered to be medium. The overall risk from the whelk pot fishery to sensitive benthic / structure forming species was **low** in the AOI (Table 2.4.8-3). There was a low level of certainty associated with this assessment due to the unknown extent of the hypothetical commercial whelk fishery in the site and the limited information on the distribution of sensitive benthic / structure forming species in the AOI.

Table 2.4.8 - 3. Risk of the whelk pot fishery to sensitive benthic / structure forming species in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Area of high fish diversity

There is no spatial overlap between the whelk pot fishery and the area of high fish diversity, resulting in a very low likelihood. There were a total of five fish species caught as bycatch in 66.67% of observes sets (Table 2.4.8-1), resulting in a high consequence score. The overall risk from the whelk pot fishery to the area of high fish diversity was **low** in the AOI (Table 2.4.8-4). There was a low level of certainty associated with this assessment based on the limited bycatch information and the unknown extent of the hypothetical commercial whelk fishery in the site.

Table 2.4.8 - 4. Risk of the whelk pot fishery to the area of high fish diversity in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

d. Atlantic cod

The whelk pot fishing area overlaps with less than 1% of the important cod habitat, resulting in a very low likelihood score. Cod were found in 8.33% of observed sets (Table 2.4.8-1), which resulted in a high consequence score. The overall risk from the whelk pot fishery to Atlantic cod was **low** in the AOI (Table 2.4.8-5). There was a low level of certainty associated with this assessment based on the limited bycatch information and the unknown extent of the hypothetical commercial whelk fishery in the site.

Table 2.4.8 - 5. Risk of the whelk pot fishery to Atlantic cod in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

e. Atlantic wolffish

The whelk pot fishing area overlaps with approximately 2.8% of important habitat for Atlantic wolffish, resulting in a low likelihood.

Wolffish have been identified as a common bycatch species in this fishery in Newfoundland and Labrador (DFO, 2009). From available bycatch data, wolffish (unspecified species) were caught in 16.67% of observed sets (Table 2.4.8-1). While Atlantic wolffish were not specifically mentioned, these fish are considered 'mollusc specialists' (DFO, 2013b) so it seems likely that this species may comprise the majority of the wolffish bycatch reported by Rawlings et al., (2009). As such, a high consequence score was assigned. The overall risk from the whelk pot fishery to Atlantic wolffish was **medium** in the AOI (Table 2.4.8-6). There was a low level of certainty associated with this assessment based on the limited bycatch information and the unknown extent of the hypothetical commercial whelk fishery in the site.

Table 2.4.8 - 6. Risk of the whelk pot fishery to Atlantic wolffish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

f. Redfish

There is no overlap between the whelk pot fishing area and the area of important redfish habitat, resulting in a very low consequence score. There were no redfish reported in the observer sets, therefore the consequence was very low. This resulted in an overall **very low** risk from the whelk pot fishery to redfish in the AOI (Table 2.4.8-7). There was a low level of certainty associated with this assessment based on the limited bycatch information and the unknown extent of the hypothetical commercial whelk fishery in the site.

Table 2.4 8 - 7. Risk of the whelk pot fishery to redfish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

g. American plaice

The whelk pot fishing area overlapped with approximately 1.6% of American plaice important habitat, resulting in a low likelihood. There were no records of American plaice in the observed sets for this fishery, resulting in a very low consequence score. The overall risk from the whelk pot fishery to American place was **very low** in the AOI (Table 2.4.8-8). There was a low level of certainty associated with this assessment based on the limited bycatch information and the unknown extent of the hypothetical commercial whelk fishery in the site.

Table 2.4.8 - 8. Risk of the whelk pot fishery to American plaice in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

g. Leatherback turtles

The whelk pot fishing area overlaps with approximately 2.9% of the important habitat for leatherback turtle, resulting in a low likelihood. While there were no records of leatherback turtle entanglements during the experimental whelk fishery study (Rawlings et al., 2009), whelk gear has been identified as an entanglement threat for turtles in the Newfoundland region (Park et al., 2011). Furthermore, up to 7 entanglements in whelk pot gear have been reported in waters off of Newfoundland and 10 entanglements have been reported in waters off of Quebec (DFO, 2012g). Therefore, the consequence was scored as high. The overall risk from the whelk pot fishery to leatherback turtles was **medium** in the AOI (Table 2.4.8-9). Note that this risk is only present to leatherback turtles when they are in the AOI during the summer foraging season. There was a low level of certainty associated with this assessment based on the limited bycatch information and the unknown extent of the hypothetical commercial whelk fishery in the site.

Table 2.4.8 - 9. Risk of the whelk pot fishery to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

h. Benthic invertebrates

Whelk are the target species of this fishery and a benthic invertebrate. However, because a future whelk fishery within the AOI would be managed by DFO, and whelk have not been identified as a specific conservation priority for the site, other benthic invertebrates that make up this functional group were the focus of this risk assessment.

Benthic invertebrates were considered to be broadly distributed across the entire AOI. As the spatial extent of the experimental whelk pot fishery is approximately 2.4% of the site, a low likelihood score was assigned. Benthic invertebrates may be damaged or crushed by whelk pots. However, for the purpose of this assessment, bycatch was considered the primary impact of concern for pot fisheries. There were several species of benthic invertebrates caught as bycatch in 100% of the observed sets (Table 2.4.8-1), resulting in a high consequence score. The overall risk of the whelk pot fishery to benthic invertebrates (other than whelk) was **medium** in the AOI (Table 2.4.8-10). There was a low level of certainty associated with this assessment based on the limited bycatch information and the unknown extent of the hypothetical commercial whelk fishery in the site.

Table 2.4.8 - 10. Risk of the whelk pot fishery to benthic invertebrates in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

i. Demersal fish

The whelk pot fishery overlaps with approximately 1.6% of the demersal fish important habitat , resulting in a low likelihood score. In additions to Atlantic cod, Atlantic wolffish, redfish and American plaice (assessed above), three demersal fish species were caught as bycatch in 66.67% of sets (Table 2.4.8-1), resulting in a high consequence score. The overall risk of the whelk pot fishery to demersal fish was **medium** in the AOI (Table 2.4.8-11). There was a low level of certainty associated with this assessment based on the limited bycatch information and the unknown extent of the hypothetical commercial whelk fishery in the site.

Table 2.4.8 - 11. Risk of the whelk pot fishery to demersal fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

j. Top predators (marine mammals)

Marine mammals were assumed to have a wide distribution across the AOI. As the spatial extent of the experimental whelk pot fishery is approximately 2.4% of the site, a low likelihood score

was assigned. While there were no records of entanglement of marine mammals in whelk fishing gear in the experimental fishery in the area (Rawlings et al., 2009), there have been concerns that this fishery poses a risk for marine mammal entanglements (DFO, 2009), and records exist for 3 minke and 10 humpback whale entanglements in Newfoundland between 1987 and 2008 (Benjamins et al., 2011). Thus, a high consequence score was assigned. The overall risk from the whelk pot fishery to top predators (marine mammals) was **medium** in the AOI (Table 2.4.8-12). There was a low level of certainty associated with this assessment based on the limited bycatch information, the unknown extent of the hypothetical commercial whelk fishery in the site, and the limited information on marine mammal presence and abundance in the area.

Table 2.4.8 - 12. Risk of the whelk pot fishery to top predators (marine mammals) in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

2.4.9 Hagfish Fishery

Hagfish off of Nova Scotia are fished using strings of 10 traps, placed 90 m apart (Louisbourg Seafoods, Limited, 2006), and the fishery generally occurs year round. The traps are constructed out of 120 litre baited plastic drums with four one-way entrance holes and approximately 100 escape holes designed to permit small hagfish and other species to exit the trap (Mugridge et al., 2007). The gear catches very little bycatch. To illustrate, the bycatch profile from one year of experimental fishing off of Nova Scotia is shown in Table 2.4.9-1.

Table 2.4.9 - 1. The bycatch from the experimental hagfish fishery off of eastern Nova Scotia in the fall of 2005 from a total of 1678 hagfish traps (Louisbourg Seafoods, Limited, 2006).

Species	Number of individuals
Shrimp	25
Sea urchins	5
Sea stars	3
Whelk	3
Crab	1
Redfish	1

There are currently three licences for hagfish fishing in 4Vn, however most of the fishing to date has occurred in the Cabot Strait area. According to available DFO data (to 2012) there is currently no hagfish fishery in the St. Anns Bank AOI. However, a recent traditional use characterization of the St. Anns Bank area identified a potential hagfish fishing area within the site (UINR and Membertou Geomatics Solutions, 2013). Although the identified area encompasses a much larger footprint than an active hagfish fishery would likely occupy, this area was used as the spatial extent of the fishery for the purposes of the risk assessment (Figure 2.4.9-1).

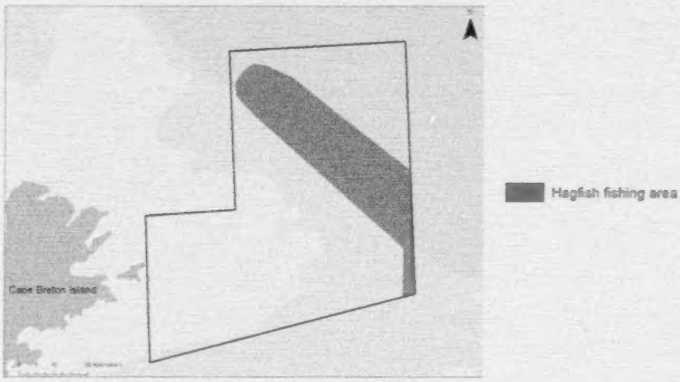

Figure 2.4.9 - 1. The proposed hagfish fishing area within the St. Anns Bank AOI (black polygon) (modified from UINR and Membertou Geomatics Solutions, 2013).

Based on the very low bycatch rates in the experimental study, the consequence of this fishery to other fish species was assumed to be very low.

Risk of the Hagfish Fishery to Conservation Priorities

a. Benthic habitats

The hagfish fishing area covers approximately 21% of the AOI (Figure 2.4.9-1), resulting in a medium likelihood. The fishing area overlaps entirely with an area of moderate natural disturbance (Figure 2.4.9-2), resulting in a low consequence score. The overall risk from the hagfish fishery to benthic habitats was **low** in the AOI (Table 2.4.9-2). There is a low level of certainty associated with this assessment because the spatial extent of the hagfish fishery is unknown.

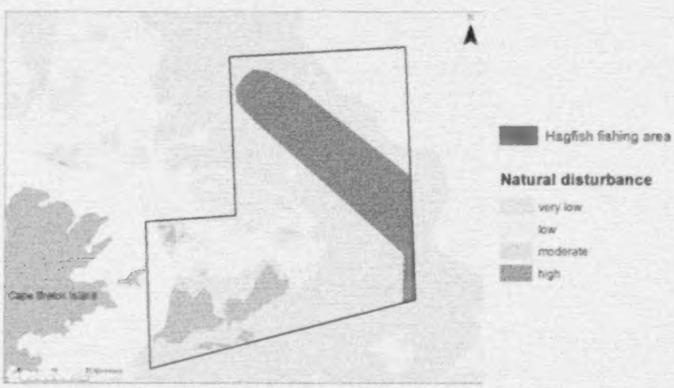

Figure 2.4.9 - 2. The spatial overlap between the proposed hagfish fishing area (modified from UINR and Membertou Geomatics Solutions, 2013) and the levels of natural disturbance (modified from Ford and Serdynska, 2013) in benthic habitats within the St. Anns Bank AOI (black polygon).

Table 2.4.9 - 2. Risk of the hagfish fishery to benthic habitats in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Sensitive benthic / structure forming species

Sensitive benthic / structure forming species are widely distributed across the AOI. The hagfish fishing area overlaps with most of the areas identified as soft coral important habitat and approximately half of the area identified as a sea pen concentration (Figure 2.4.9-3). The area covers approximately 21% of the site, resulting in a medium likelihood.

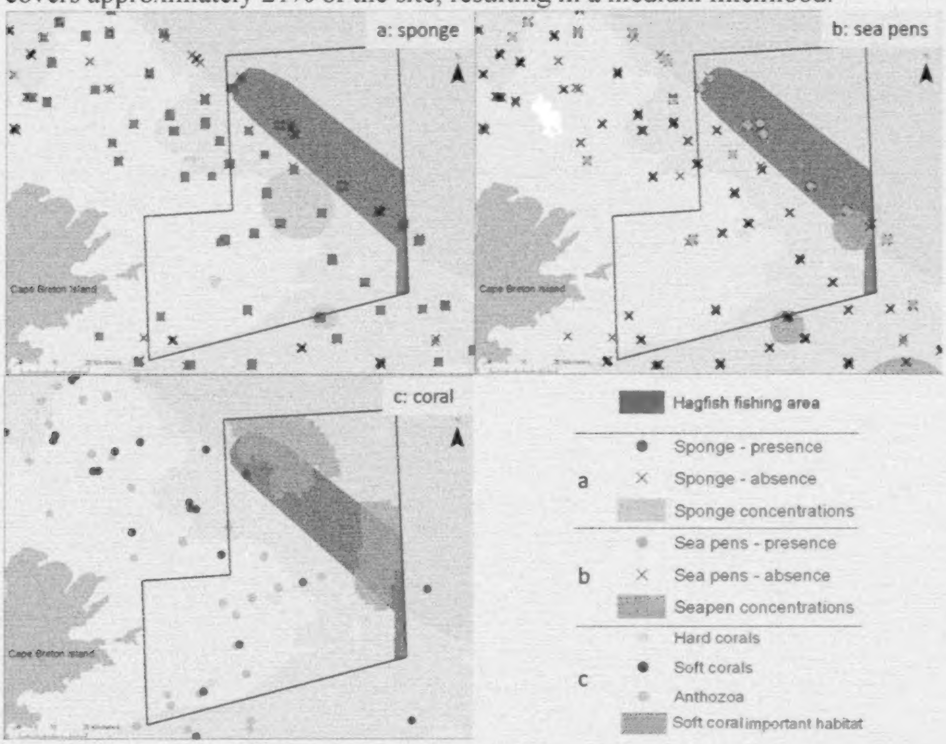

Figure 2.4.9 - 3. a) The spatial overlap between the proposed hagfish fishery area and locations of a) sponge presence and absence from the RV survey and the sponge concentrations (modified from Kenchington et al. 2010), b) sea pen presence and absence from the RV survey and the sea pen concentrations (Kenchington et al. 2010), c) different coral types and the soft coral important habitat in and around the St. Anns Bank AOI (black polygon).

Bottom-contacting fixed gear, such as hagfish gear, has the potential to crush sensitive benthic / structure forming species, and damage can also occur as pots are dragged across the seafloor in strong currents (DFO, 2010c). Similar to the lobster and snow crab fisheries, damage can

occasionally occur with hagfish pots, so the consequence level was considered to be medium. The overall risk from the hagfish fishery to sensitive benthic species was **medium** in the AOI (Table 2.4.9-3). There was a low level of certainty associated with this assessment based on the limited knowledge of the locations of sensitive benthic / structure forming species and because the spatial extent of the hagfish fishery is unknown.

Table 2.4.9 - 3. Risk of the hagfish fishery to sensitive benthic species in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Area of high fish diversity

The hagfish fishing area overlaps with more than 50% of the area of high fish diversity (Figure 2.4.9-4), resulting in a high likelihood. The hagfish fishery is a minimal bycatch fishery (Table 2.4.9-1) so the consequence was considered to be very low. This resulted in an overall **low** risk from the hagfish fishery to the area of high fish diversity in the AOI (Table 2.4.9-4). There was a low level of certainty associated with this assessment because the spatial extent of the hagfish fishery is unknown.

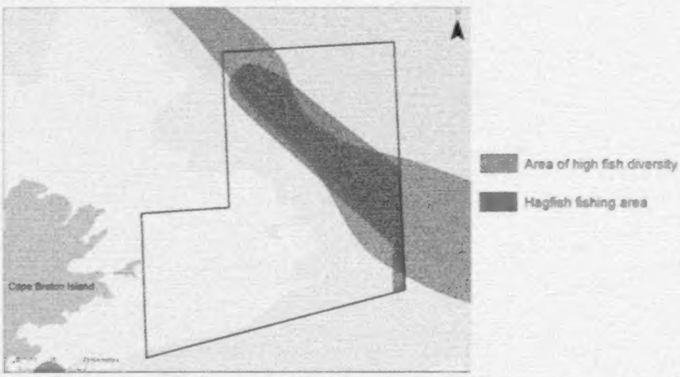

Figure 2.4.9 - 4. The spatial overlap between the proposed hagfish fishing area (modified from UINR and Membertou Geomatics Solutions, 2013) and the area of high fish diversity (modified from Ford and Serdynska, 2013) within the St. Anns Bank AOI (black polygon).

Table 2.4.9 - 4. Risk of the hagfish fishery to the area of high fish diversity in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

d. Atlantic cod

The hagfish fishing area overlaps with approximately 20% of the important Atlantic cod habitat (Figure 2.4.9-5), resulting in a medium likelihood. The hagfish fishery has minimal bycatch (Table 2.4.9-1), so the consequence was considered to be very low. This resulted in an overall risk of **low** from the hagfish fishery on Atlantic cod in the AOI (Table 2.4.9-5). There was a low level of certainty associated with this assessment because the spatial extent of the hagfish fishery is unknown.

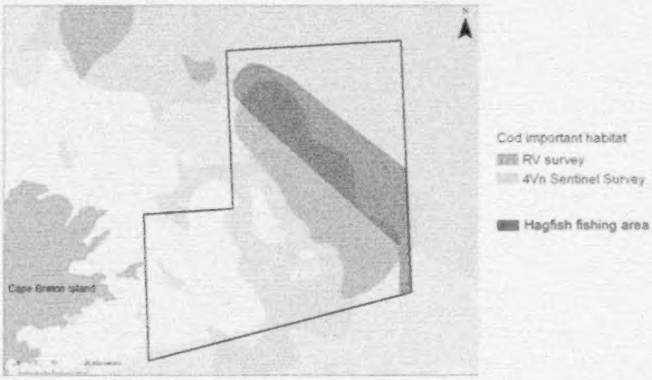

Figure 2.4.9 - 5. The spatial overlap between the proposed hagfish fishing area (modified from UINR and Membertou Geomatics Solutions, 2013) and important Atlantic cod habitat in the St. Anns Bank AOI (black polygon), identified using data from the RV survey (Horsman and Shackell, 2009) and the sentinel survey.

Table 2.4.9 - 5. Risk of the hagfish fishery to Atlantic cod in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

e. Atlantic wolffish

The hagfish fishing area overlaps with less than 10% of the important habitat for Atlantic wolffish (Figure 2.4.9-6), resulting in a low likelihood. The hagfish fishery has minimal bycatch (Table 2.4.9-1), so the consequence was considered very low. This resulted in a **very low** risk from the hagfish fishery to Atlantic wolffish in the AOI (Table 2.4.9-6). There was a low level of certainty associated with this assessment because the spatial extent of the hagfish fishery is unknown.

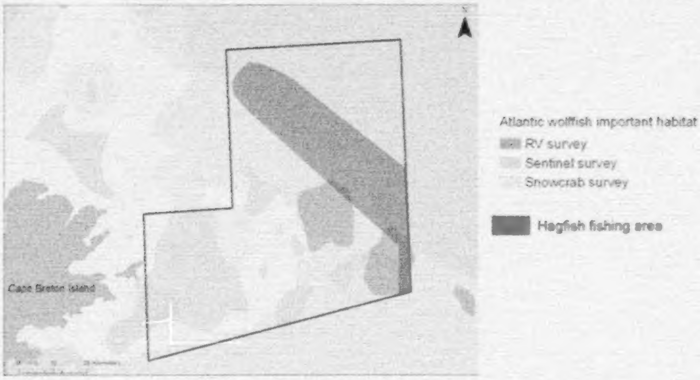

Figure 2.4.9 - 6. The spatial overlap between the proposed hagfish fishing area (modified from UINR and Membertou Geomatics Solutions, 2013) and important Atlantic wolffish habitat in the St. Anns Bank AOI (black polygon), identified through data from the RV survey (Horsman and Shackell, 2009), and the sentinel and snow crab surveys.

Table 2.4.9 - 6. Risk of the hagfish fishery to Atlantic wolffish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

f. Redfish

The hagfish fishing area overlaps with more than 50% of the important habitat for Redfish (Figure 2.4.9-7), resulting in a high likelihood. There is minimal bycatch in the hagfish fishery (Table 2.4.9-1), so the consequence was considered to be very low. This resulted in a **low** risk from the hagfish fishery to redfish in the AOI (Table 2.4.9-7). There was a low level of certainty associated with this assessment because the spatial extent of the hagfish fishery is unknown.

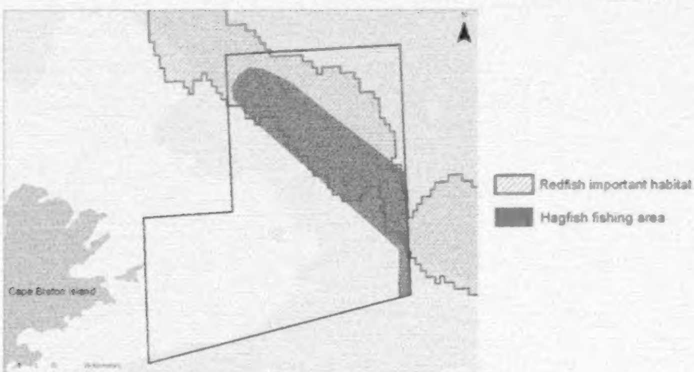

Figure 2.4.9 - 7. The spatial overlap between the proposed hagfish fishing area (modified from UINR and Membertou Geomatics Solutions, 2013) and important redfish habitat within the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Table 2.4.9 - 7. Risk of the hagfish fishery to redfish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

g. American plaice

There was no overlap between the hagfish fishing area and the important habitat for American plaice (Figure 4.2.9-8), resulting in a very low likelihood. The hagfish fishery is a very low bycatch fishery (Table 2.4.9-1), so the consequence was considered to be very low. This resulted in an overall **very low** risk from the hagfish fishery to American plaice in the AOI (Table 4.2.9-8). There was a low level of certainty associated with this assessment because the spatial extent of the hagfish fishery is unknown.

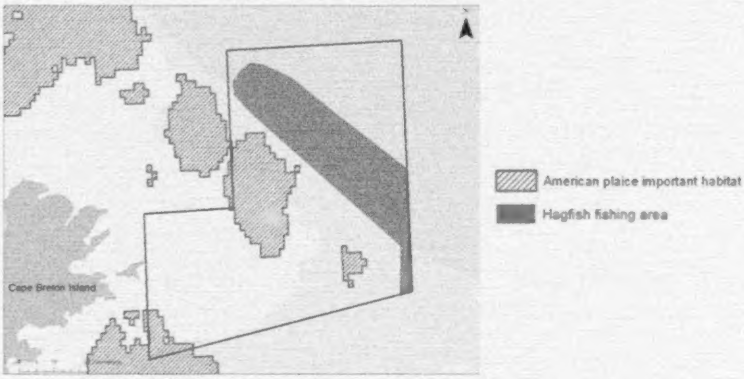

Figure 2.4.9 - 8. The spatial overlap between the proposed hagfish fishing area (modified from UINR and Membertou Geomatics Solutions, 2013) and important habitat for American plaice in the St. Anns Bank AOI (black polygon), modified from Horsman and Shackell (2009).

Table 2.4.9 - 8. Risk of the hagfish fishery to American plaice in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

h. Leatherback Turtles

The hagfish fishing area overlaps with approximately 20% of the important habitat for leatherback turtles in the AOI (Figure 2.5.9-9), resulting in a medium likelihood. There have been no records in the Maritimes of leatherback entanglements in hagfish fishing gear (DFO, 2012g) and a study reviewing the impact of gear types determined that it was rare for leatherback entanglements in hagfish gear to occur in the Maritimes Region (DFO, 2007a), so the

consequence was very low. This results in an overall **low** risk from the hagfish fishery to leatherback turtles in the AOI (Table 2.4.9-9). There was a low level of certainty associated with this assessment based on the paucity of information about interactions between the hagfish fishery and leatherback turtles, and because the spatial extent of the hagfish fishery is unknown. Note that the risk to leatherbacks from the hagfish fishery would only be present in the summer months when leatherbacks are in the area.

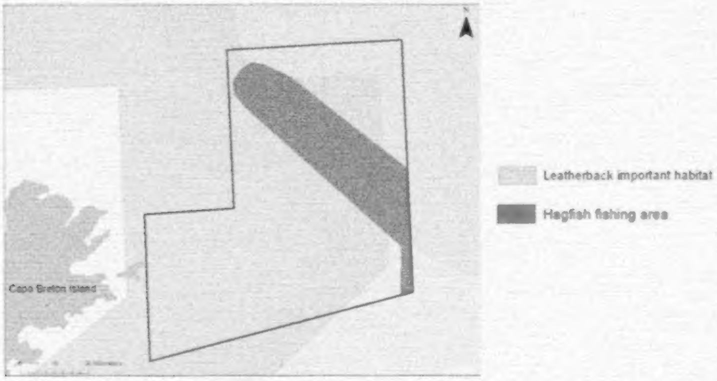

Figure 2.4.9 - 9. The spatial overlap between the proposed hagfish fishing area (modified from UINR and Membertou Geomatics Solutions, 2013) and important habitat for leatherback turtles in the St. Anns Bank AOI (black polygon).

Table 2.4.9 - 9. Risk of the hagfish fishery to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

i. Benthic invertebrates

Benthic invertebrates were assumed to be widely distributed across the AOI, resulting in an overlap of approximately 21% with the hagfish fishing area and a medium likelihood. Benthic invertebrates may be damaged or crushed by this gear type. However, for the purpose of this assessment, bycatch was considered the primary impact of concern for pot fisheries. There is very little bycatch in this fishery, so the consequence was considered to be very low. The overall risk from the hagfish fishery to benthic invertebrates was **low** in the AOI (Table 2.4.9-10). There was a low level of certainty associated with this assessment because the spatial extent of the hagfish fishery is unknown.

Table 2.4.9 - 10. Risk of the hagfish fishery to benthic invertebrates in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

j. Demersal fish

The hagfish fishing area overlaps with approximately 25% of the important area for demersal fish (Figure 2.4.9-10), resulting in a medium likelihood score. The hagfish fishery is a very low bycatch fishery (Table 2.4.9-1), so the consequence was very low, and the overall risk from the hagfish fishery to demersal fish was **low** in the AOI (Table 2.4.9-11). There was a low level of certainty associated with this assessment because the spatial extent of the hagfish fishery is unknown.

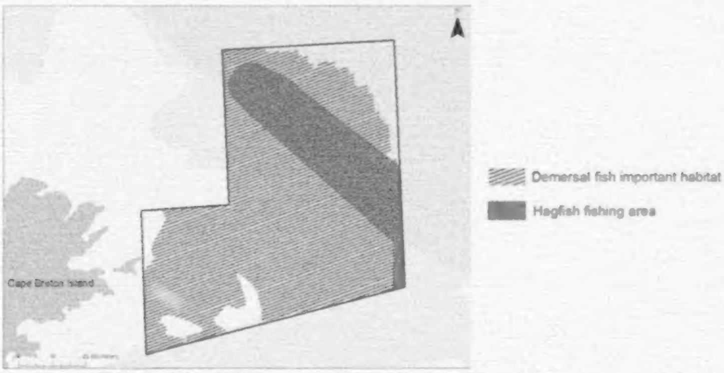

Figure 2.4.9 - 10. The spatial overlap between the proposed hagfish fishing area and important habitat for demersal fish in the St. Anns Bank AOI (black polygon).

Table 2.4.9 - 11. Risk of the hagfish fishery to demersal fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

k. Top predators (marine mammals)

Whales were assumed to be widely distributed across the site, resulting in an overlap with the hagfish fishery of approximately 25% and a medium likelihood score. There have been two records of humpback whale entanglements in hagfish gear in the Northwest Atlantic (Johnson et al., 2005; Derek Fenton, Oceans Biologist, personal communication). Thus a medium consequence score was assigned. The overall risk from the hagfish fishery to top predators

(whales) was **medium** in the AOI (Table 2.4.9-12). There was a low level of certainty associated with this assessment because the spatial extent of the hagfish fishery is unknown.

Table 2.4.9 - 12. Risk of the hagfish fishery to top predators (whales) in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

2.4.10 Seal Harvest

The harp seal harvest is very different from other fisheries occurring in the area; it occurs exclusively on the surface of the AOI and targets individual animals, thus there is no chance of bycatch or harm to other species. The harvest occurs between late March to mid-April, and is managed through an Integrated Fisheries Management Plan, which sets a total allowable catch limit on seals based on population estimates. Routine surveys of the seal populations occur approximately every five years and population estimates based on those surveys suggest that the harp seal population is reaching its carrying capacity (DFO, 2011c). The Maritimes provinces and the Gulf of St. Lawrence are allotted 2% of the Eastern Canada total harp seal quota (DFO, 2011c).

Geographic information on the seal hunt in the St. Anns Bank area is extremely limited. This is due in part to the low level of effort in the area, and also due to poor compliance with reporting requirements. Harp seal harvesting may occur within or nearby the St. Anns Bank AOI when ice conditions are suitable (most recently in 2008; DFO, 2012d). For the purpose of this assessment, the spatial extent of the harvest is considered to be the entire AOI.

Risk of the Seal Harvest to Conservation Priorities

a. Top predators

Seals fall under the category of top predators and are the target of this fishery; however, the harvest is managed by DFO with limits on the allowable number of seals to be harvested. As well, seals were not identified as a specific conservation priority for the site. As such, top predators other than seals were the focus of the assessment for this functional group.

Top predators are assumed to have a wide distribution across the AOI. Because the spatial extent of the predicted seal harvesting area includes the entire AOI, a high likelihood score was assigned. Considering that the harvest targets individual animals, a very low consequence score was assigned, and the overall risk of the seal harvest to top predators was considered to be low (Table 2.4.10 - 1). There was a moderate level of certainty associated with this assessment because while the impacts of the harvest are well-understood, the true extent of the seal hunt within the AOI boundaries cannot be determined due to the absence of commercial harvest data.

Table 2.4.10 - 1. Risk of the seal harvest to top predators.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

2.5 Summary

The risks presented by commercial fishing activity in the St. Anns Bank AOI were determined from available catch and observer data and literature. Table 2.5-1 contains the risk scores for all activities and conservation priorities in the AOI.

The assessment of risk from fishing activities resulted in high risk scores to many fish-related conservation priorities from redfish bottom and midwater trawl due to bycatch. Bottom trawl was also determined to present high risk to benthic habitats and sensitive benthic/structure-forming species. While the halibut longline fishery presented low risks to leatherback turtles, sensitive benthic/structure forming species, and benthic invertebrates, medium to high risk scores were assigned to fish-related conservation priorities primarily due to bycatch of depleted/at-risk fish species. Lower impact bottom-contacting fisheries such as the snow crab and whelk pot fisheries posed medium to high risks to turtles and marine mammals due to entanglement, but low or very low risks to most other conservation priorities. The lobster pot fishery and gillnet fisheries for herring roe and bait received low or very low risk scores for all conservation priorities, and the proposed hagfish fishery was determined to pose a medium risk to marine mammals and sensitive benthic/structure forming species, but low or very low risks to all other conservation priorities. The seal harvest was determined to pose a low risk to top predators.

Table 2.5 - 1. A summary of the risk scores and respective certainty scores for the fisheries within the St. Anns Bank AOI.

Conservation Priority	Risk Level	Certainty Level
Snow crab pot fishery		
Benthic habitats	Low	Moderate
Sensitive benthic / structure forming species	Low	Low
Area of high fish diversity	Low	Moderate
Atlantic cod	Low	Moderate
Atlantic wolffish	Low	Moderate
Redfish	Very low	Moderate
American plaice	Low	Moderate
Leatherback turtles[1]	High	Moderate
Benthic invertebrates	Low	Moderate
Demersal fish	Low	Moderate
Top predators (marine mammals)	Medium	Low
Lobster pot fishery		
Benthic habitats	Low	Low
Sensitive benthic/structure forming species	Low	Very low
Area of high fish diversity	Very low	Low
Atlantic cod	Low	Low
Atlantic wolffish	Very low	Low

Conservation Priority	Risk Level	Certainty Level
Redfish	Very low	Low
American plaice	Very low	Low
Leatherback turtles[1]	Low	Low
Benthic invertebrates	Low	Low
Demersal fish	Low	Low
Top predators (marine mammals)	Low	Low
Redfish otter trawl fishery		
Benthic habitats	High	Moderate
Sensitive benthic / structure forming species	High	Low
Area of high fish diversity	High	Moderate
Atlantic cod	High	Moderate
Atlantic wolffish	Low	Moderate
Redfish	High	High
American plaice	Low	Moderate
Leatherback turtles[1]	Low	Low
Benthic invertebrates	Medium	Moderate
Forage fish	Low	Low
Demersal fish	High	Moderate
Top predators (sharks)	Low	Low
Redfish midwater trawl fishery		
Benthic habitats	Low	Low
Sensitive benthic / structure forming species	Low	Very low
Area of high fish diversity	High	Low
Atlantic cod	High	Low
Atlantic wolffish	Low	Low
Redfish	High	Moderate
American plaice	Very low	Low
Leatherback turtles[1]	Low	Very low
Benthic invertebrates	Low	Low
Forage fish	Low	Low
Demersal fish	High	Low
Top predators (sharks)	Medium	Low
Halibut bottom longline		
Benthic habitats	Low	Moderate
Sensitive benthic / structure forming species	Low	Low
Area of high fish diversity	High	Moderate
Atlantic cod	High	Moderate
Atlantic wolffish	Medium	Moderate
Redfish	Medium	Moderate
Leatherback turtles[1]	Low	Low
Benthic invertebrates	Low	Moderate
Demersal fish	High	Moderate
Top predators (sharks)	Low	Low
Herring roe gillnet fishery		
Area of high fish diversity	Very low	Very low
Atlantic cod	Very low	Very low
Atlantic wolffish	Low	Very low
Redfish	Very low	Very low
American plaice	Low	Very low
Leatherback turtles	Low	Low
Forage fish	Low	Very low
Demersal fish	Very low	Very low

Conservation Priority	Risk Level	Certainty Level
Top predators (all)	Low	Very low
Gillnet bait fishery		
Area of high fish diversity	Very low	Very low
Atlantic cod	Very low	Very low
Atlantic wolffish	Very low	Very low
Redfish	Very low	Very low
American plaice	Very low	Very low
Leatherback turtles	Low	Very low
Forage fish	Very low	Very low
Demersal fish	Very low	Very low
Top predators (marine mammals)	Low	Very low
Whelk pots		
Benthic habitats	Low	Very low
Sensitive benthic / structure forming species	Low	Low
Area of high fish diversity	Low	Low
Atlantic cod	Low	Low
Atlantic wolffish	Medium	Low
Redfish	Very low	Low
American plaice	Very low	Low
Leatherback turtles[1]	Medium	Low
Benthic invertebrates	Medium	Low
Demersal fish	Medium	Low
Top predators (marine mammals)	Medium	Low
Hagfish fishery		
Benthic habitats	Low	Low
Sensitive benthic / structure forming species	Medium	Low
Area of high fish diversity	Low	Low
Atlantic cod	Low	Low
Atlantic wolffish	Very low	Low
Redfish	Low	Low
American plaice	Very low	Low
Leatherback turtles[1]	Low	Low
Benthic invertebrates	Low	Low
Demersal fish	Low	Low
Top predators (marine mammals)	Medium	Low
Seal harvest		
Top predators	Low	Moderate

[1]Risk only present in summer months when leatherbacks are present

3.0 OIL AND GAS EXPLORATION

3.1 Sector Overview

Exploratory oil and gas activities that might be conducted in the St. Anns Bank AOI include seismic surveys and exploratory drilling. Seismic surveys are conducted to identify potential hydrocarbon reserves, but seismic data alone is insufficient to determine whether or not hydrocarbons are present (LGL Ltd., 2005). Exploratory drilling is conducted to confirm the existence of a petroleum reservoir suggested by seismic survey data, and to better delineate the extent of the resource.

Seismic surveys use sound waves to collect information about the geology of an area and to determine the potential for commercial deposits of hydrocarbons (DFO, 2011d). In general, these surveys are carried out by a vessel towing an array of air guns that produce sound, and a seismic streamer containing hydrophones that receive the sound after it is reflected back from the seabed. The data are then processed into an acoustic image of the geological strata under the seafloor. Two dimensional (2D) seismic surveys are conducted using a single air gun array and one seismic streamer to map the subsurface geology along widely spaced transect lines. Geologists use these data to identify potential reservoirs, traps and structures which may contain hydrocarbons. Three dimensional (3D) surveys are conducted along more closely spaced transect lines. In general, 3D surveys are conducted before a final drilling location is selected, as they provide much more detailed 3D images of prospective areas. 3D surveys can be conducted using narrow azimuth (NAZ) or wide azimuth (WAZ) configurations. NAZ surveys use a single vessel pulling multiple airgun arrays and a streamer array pulling six to twelve streamer cables, whereas WAZ surveys employ multiple vessels towing multiple airgun and streamer arrays. WAZ surveys are used in areas with complex geology, as they permit the collection of seismic sound from a wider range of reflection angles. Because multiple vessels are used during WAZ surveys, the operational footprint of the survey is much larger than a typical NAZ survey. The duration of a typical seismic survey ranges from 14 to 30 days.

Sound transmission in the ocean is influenced by oceanographic parameters such as temperature, salinity, density, and depth (Davis et al., 1998). While sound may attenuate rapidly in shallow waters, in deeper waters it can propagate with little attenuation over much longer distances. In fact, one study detected seismic noise over 3000 km away from the source (Nieukirk et al., 2004). Typical peak source levels for exploratory seismic surveys are 245-260 decibels (dB) [relative to 1 micro Pascal (μPa) observed for an equivalent point acoustic source at 1 m range] in the downward direction, with most energy in the 5-300 hertz (Hz) frequency range (DFO, 2011d). Seismic air guns generally emit pulses of noise every 10 to 15 seconds.

Exploratory drilling may be undertaken from a jack-up rig with legs standing on the sea bottom, or from floating semi-submersible rigs or deepwater drill ships (Hurley, 2009). Drilling operations typically run for one to three months (DFO, 2011d). Drilling involves the production of light and noise, and the discharge of muds, cuttings and other liquid wastes.

Drill muds are fluids that are circulated in oil and gas wells to cool and lubricate the drill bit, to counterbalance subsurface hydrostatic pressure, and to bring cuttings up to the surface through the drill pipes (DFO, 2011d). Drill muds can be water-, mineral oil-, oil- or synthetic-based fluids, and typically contain barite or bentonite as weighting agents as well as chemical additives that act as emulsifiers, biocides, surfactants, lubricants, wetting agents, etc. Drill solids or

cuttings are particles of rock or rock dust that are generated by drilling into subsurface formations. These particles are carried to the surface along with drill muds and are usually disposed of at sea at the well site. Liquid wastes can include typical operational wastes associated with vessel operation (i.e., ballast water, bilge water, and deck drainage) and produced water. The latter is water present in the reservoir that is brought up to a platform or drill rig, treated and either re-injected in the well or discharged at sea. Produced water is not generally discharged in significant quantities during the drilling of an exploratory well (DFO, 2011d).

Drilling activities produce continuous noise, as opposed to the pulsed noise produced in seismic surveys. Noise produced from drilling activities varies with the type of rig used, but in general drilling noise is considerably quieter than noise produced from seismic activities. Drill ships with hull-mounted machinery are relatively noisy (e.g., broadband source levels generated from one such vessel was measured at 191dB µPa at 1 meter range) with prominent tones up to 600 Hz (reviewed in Richardson et al., 1995). In comparison, noise produced from semi-submersible rigs has been measured at 154 dB re 1 µPa at 1 meter range with prominent tones up to 300 Hz. Broadband levels produced from semi-submersible rigs were reported to diminish to ambient levels beyond ~1 km from the source. The quietest drilling noises are produced from jack-up rigs, with received levels measured at ~119-127 dB re 1 µPa at near field measurement ranges. The most prominent tones produced from these rigs were measured at frequencies near 5 Hz.

Rare events such as accidental spills and blowouts can also occur as part of exploratory drilling activities. A blowout occurs when an operator loses control of the flow of oil, gas and/or other fluids during oil and gas drilling operations (DFO, 2011d). The amount of material and type of environmental impacts depends on the nature of the accident. Specifically, a blowout occurring at the seafloor will impact the benthic environment. A blowout or spill from the drilling platform will have direct effects on the sea surface. Oil from sea surface slicks may also mix into the water column and seafloor sediments, depending on oceanographic conditions. While volatile organic compounds in the spill evaporate and/or dissolve into the water immediately, heavier materials such as crude oil will persist and breakdown through weathering processes such as spreading, dispersion, emulsification, photo-oxidation, microbial degradation, adsorption, and sedimentation. Factors influencing the behavior and rate of degradation of spilled hydrocarbons include wind, temperature, salinity, waves, tides and currents (reviewed in DFO, 2011d).

In addition to the other pressures discussed above, seismic vessels, drill rigs, and supply vessels all use lighting for navigation and to help illuminate work areas after dark (LGL, 2010). Drill rigs also engage in flaring activities which produce both heat and light.

Existing Mitigation

Regulations and guidelines dictate most offshore mitigation measures. Regulations and guidelines are administered by the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) for offshore oil and gas activities off Nova Scotia. It must be noted that in many cases, operational guidelines have been drafted based on best practices developed by industry operators. In addition to established guidelines, an environmental assessment must be undertaken before a seismic survey or drilling program can be authorized by the Board. Additional mitigation identified through the environmental assessment process become mandatory as conditions of a project's authorization.

The *Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment* (the Statement) outlines "mitigation requirements that must be met during the planning and conduct of marine seismic surveys, in order to minimize impacts on life in the oceans" (DFO, 2007b, p. 1). The Statement includes requirements to plan a survey so as to avoid significant adverse effects on individual marine mammals or sea turtles listed under *SARA* or population-level adverse effects on other species. Additional planning considerations are included to protect breeding, feeding, nursing and migrating marine mammals and aggregations of spawning and migrating fish. Operational mitigation measures outlined in the Statement include the requirement for a qualified onboard marine mammal observer and the establishment of a 500 metre safety zone within which no cetacean, sea turtle, or other at risk marine mammal should be present for at least 30 minutes prior to a gradual ramping up of the airgun array. Furthermore, during the conduct of a survey, the array must be shut down if a marine mammal or turtle listed as threatened or endangered is seen within the safety zone. Passive acoustic monitoring is required if the safety zone is not fully visible and the program is in an area identified as critical habitat for a vocalizing cetacean listed as endangered or threatened under *SARA*.[4]

In addition to the mitigation measures outlined in the Statement, additional commitments to seismic mitigation may be made through the environmental assessment process. For example, in a recent Environmental Assessment to conduct a 3D seismic survey in Shelburne Basin, Shell Canada committed to conducting passive acoustic monitoring in addition to visual monitoring to ensure no marine mammal or sea turtle species listed on Schedule 1 of *SARA*, or other baleen whales and sea turtles, were within a 1000 metre safety zone during the pre-ramp up watches (LGL, 2013). Other marine mammals must not be detected within a 500 metre safety zone during the pre-ramp up period. The company also committed to shutting down airguns if baleen whales, sea turtles, or any other *SARA*–listed marine mammals were detected within the 1000 metre safety zone during an active survey, and to wait to restart the survey until the whale left the area or 30 minutes (60 minutes for northern bottlenose and Sowerby's whales) had passed since the last detection.

There are a number of additional regulatory requirements and associated guidelines to minimize environmental impacts from oil and gas exploration. For example, chemicals and substances that make up drilling muds are screened under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands*. The *Drilling and Production Regulations* require operators to submit an Environmental Protection Plan. A spill contingency plan must also be submitted to the CNSOPB. Additional certification requirements are also in place to help ensure that seismic vessels and drill rigs can be operated safely without polluting the environment.

The *Offshore Waste Treatment Guidelines* outline recommended practices for the management of waste materials from petroleum drilling and production operations in Canada's offshore areas (National Energy Board et al., 2010). With respect to drill muds and cuttings, these Guidelines and the CNSOPB require that wherever possible operators use water-based muds for drilling

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[4] A Canadian Science Advisory process is planned for 2013/2014 to review existing mitigation and provide advice on additional measures to be considered to minimize potential impacts of seismic sound on vulnerable *at risk* species.

wells. Water-based muds and associated cuttings may be discharged on site. Operators are also permitted to use synthetic- and mineral oil-based muds. While these muds may not be discharged at sea, the associated cuttings may be discharged on site. While operators are permitted to use oil-based muds in exceptional circumstances, muds and associated cuttings must not be discarded at sea.

Further mitigation measures for exploratory drilling that have been employed in offshore Nova Scotia waters near sensitive marine areas include the requirement for a pre-spud survey to confirm the absence of coral formations, the down-shading and focusing of lighting on the work areas of offshore platforms to minimize the attraction of seabirds, and the use of heavy brine instead of barite in the drill fluids to reduce the release of mercury compounds into the environment (Hurley, 2009). As well, a recent Strategic Environmental Assessment for offshore petroleum exploration (including exploratory drilling) in Misaine and Banquereau Banks recommends that special areas that are important for sensitive lifecycle stages, such as spawning and juvenile areas, should be avoided during times of year when these stages are present (Stantec Consulting Ltd., 2013).

3.2 Scope of the Oil and Gas Risk Assessment

Much of the AOI has been recognized as an area with potential to be developed for oil and gas extractions (Hannigan and Dietrich, 2012). However, there is currently no oil and gas activity, exploration licences, associated work expenditure bids, or other petroleum rights within the AOI. As such, attempts to forecast what developmental activities might take place within the site would be highly speculative. Thus, and in accordance with DFO (2012c) advice to restrict the assessment to activities currently occurring or projected to occur in the near future, the assessment of risks presented by oil and gas activities within the AOI was limited to a study of interactions between the conservation priorities and pressures associated with exploratory oil and gas activities (seismic surveys, light production, drill muds and cuttings, drilling-associated noise, and accidental spills and blow-outs). For an assessment of the risks associated with vessel-related operational discharges (e.g., ballast water and oily bilge water), refer to the marine transportation sector assessment (Section 4.0).

3.3 Methods

Potential for interaction

The conservation priorities considered in the assessment of risk from seismic surveys included all those related to fish, invertebrates, marine mammals, turtles or birds that spend some part of their life in the water column (Table 3.3-1). For assessments of pressures from exploratory drilling, conservation priorities considered in the assessment of risk presented by operational discharges (specifically muds and cuttings) included those related to the benthos, including demersal fish species, spawning areas for forage fish, benthic invertebrates and benthic habitats. Conservation priorities considered in the assessment of risk from drilling-associated noise included those related to fish, marine mammals and leatherback turtles. Conservation priorities considered in the assessment of risk from drill rig and vessel lighting included top predators (i.e., seabirds) and other species or species groups that spend time at or near the surface of the water column (e.g., forage fish, zooplankton, etc.). All conservation priorities were considered in the assessment of risk from accidental spills and blowouts.

Table 3.3 - 1. Potential for interaction between conservation priorities and oil and gas exploration in St. Anns Bank. Dark blue shading indicates a known potential for interaction, light blue shading indicates an interaction may exist, and white cells indicate conservation priorities where no interaction is expected.

Conservation Priority	Seismic Surveys	Light	Exploratory Drilling		
			Operational discharges (muds, cuttings)	Drilling noise	Spills and blowouts
Habitat					
Benthic habitats					
Structure forming/sensitive benthic species					
Biodiversity					
Area of high fish diversity					
Atlantic cod					
Atlantic wolffish					
Redfish					
American plaice					
Leatherback turtles					
Productivity					
Primary producers					
Zooplankton					
Benthic invertebrates					
Forage fish					
Demersal fish					
Top predators					

To simplify the analysis, the conservation priorities were analysed in groups that were consistent with the available literature on environmental impacts of oil and gas exploration related activities. For example, groupings may include:

- Fish [area of high fish diversity, Atlantic cod, Atlantic wolffish, redfish, American plaice, forage fish, demersal fish, top predators (sharks)]
- Invertebrates and primary producers (benthic habitats, structure forming/sensitive benthic species, other benthic invertebrates, zooplankton, primary producers)
- Leatherback turtles
- Top predators (marine mammals and seabirds)

<u>Likelihood levels</u>

Using a qualitative assessment of the geological setting and known petroleum plays in the Laurentian Channel, Hannigan and Dietrich (2012) identified regions of high, moderate and low petroleum prospectivity for a larger area that included the St. Anns Bank AOI. Within the AOI

(approximately 5100 km^2 in total), an area of about 1500 km^2 was identified as having high potential, an area of 1400 km^2 had moderate potential, and an area of 2100 km^2 had low or no oil and gas development potential (Figure 3.3-1).

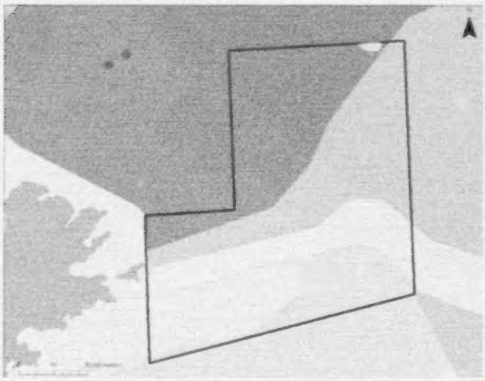

Figure 3.3 - 1. Qualitative ranking of conventional petroleum potential for St. Anns Bank and surrounding area (adapted from Hannigan and Dietrich, 2012). Red indicates the area assessed to have relatively high petroleum potential, orange indicates areas with moderate potential, and yellow indicates the area assessed to have low petroleum potential. The unshaded area was not assessed and is outside of the area considered prospective by the CNSOPB. The dots in the northwest quadrant of the map indicate the locations of test wells drilled in 1974 and 1976.

To assign relative levels of likelihood for an interaction to occur, we considered the spatial overlap of the conservation priorities with the areas assessed by Hannigan and Dietrich (2012) to have high or moderate petroleum potential (Table 3.3-2). Note that because this spatial approach to analyzing likelihood does not allow for the consideration of the probability of an event occurring, for cases where the event probability was low (e.g., accidental spills and blowouts), the worst case scenario was assessed, and the low probability of the event was acknowledge as a caveat to the assigned risk score.

Table 3.3 - 2. Likelihood definitions for the oil and gas risk assessment for the St. Anns Bank AOI.

Likelihood level	Definition
Very low	< 1% of the conservation priority area overlaps with areas of moderate or high petroleum potential
Low	< 10% of the conservation priority area overlaps with areas of moderate or high petroleum potential
Medium	10-50% of the conservation priority area overlaps with areas of moderate or high petroleum potential
High	> 50% of the conservation priority area overlaps with areas of moderate or high petroleum potential

Consequence levels

Relative levels of consequence used in this assessment are defined in Table 3.3-3. Consequence levels were determined based on impacts to local populations. In many cases, consequence level

determinations were driven by considerations for impacts on at-risk and depleted species, as adverse impacts have more potential to affect these populations.

This assessment focused on the nature and distribution of activities and ecological features within the AOI boundaries, taking into account the conservation objectives for the proposed MPA. The consequence scores for oil and gas exploration as determined through this exercise do not necessarily represent DFO's assessment of consequences for the same activities elsewhere in the Scotian shelf bioregion.

Table 3.3 - 3. Consequence definitions for the oil and gas risk assessment for the St. Anns Bank AOI.

Consequence level	Definition
Very low	Impacts are undetectable
Low	Impacts occur but recovery is rapid and there are no long term effects
Medium	Impacts occur and recovery is measured in months - 1 year
High	Impacts occur and recovery is measured in years - decades

Sources of Information

The consequences presented by oil and gas exploration-related activities to the St. Anns Bank conservation priorities were determined through a review of available literature, including strategic environmental assessments and other literature reviews on the potential ecological impacts of oil and gas development.

3.4 Risk Assessment for Oil and Gas Exploration in St. Anns Bank AOI

3.4.1 Seismic Surveys

Seismic programs have been undertaken in the Sydney Basin, Laurentian Channel and adjacent areas during pulses of exploration activity since the late 1960s. The most recent programs include a 2D seismic survey by Hunt Oil in 2005 (partly within the northwest portion of the AOI) and a 2D program by Husky Energy in 2010 within their exploration licence area northeast of the AOI. The scope of Husky's environmental assessment (study area covers the northeast corner of the AOI) includes proposed 3D surveys to be conducted sometime between 2011 and 2018 (Husky Energy, 2010).

Future programs are difficult to predict, however a reasonable assumption is that one or more 2D seismic programs may be undertaken to provide a snapshot of underlying geological prospects, particularly in the area of high petroleum potential located in the northern half of the AOI (Figure 3.3.2-1). These 2D programs may be followed by a 3D seismic program to provide a more detailed subsurface picture, typically within a smaller geographical area.

Risk of Seismic Activity to Conservation Priorities

a. Fish [i.e., area of high fish diversity, Atlantic cod, Atlantic wolffish, redfish, American plaice, forage fish, demersal fish, top predators (sharks)]

Most of the area of high fish diversity within the St. Anns Bank AOI overlaps with areas of moderate or high petroleum potential (Figure 3.4.1-1a). About half of the important habitats identified for Atlantic cod (including over-wintering grounds) and Atlantic wolffish in the AOI

are in areas considered to be of moderate or high petroleum potential (Figure 3.4.1-1b and 3.4.1-1c, respectively). Furthermore, most of the important habitats identified for redfish and American plaice within the AOI overlap with areas considered to have moderate or high petroleum potential (Figure 3.4.1-1d and Figure 3.4.1-1e, respectively). When considered together, important habitat for demersal fish (including habitats for Atlantic cod, Atlantic wolffish, redfish, American plaice, witch flounder, and white hake) encompasses the majority of the site (Figure 3.4.1-1f). Forage fish (including herring, capelin and mackerel) are also considered as a group to be broadly distributed across the site. While mackerel distribution and abundance within St. Anns Bank is not well characterized, these fish are known to travel through the site in May-July and again in October-November as part of an annual migration in and out of the Gulf of St. Lawrence (Ford and Serdynska, 2013).

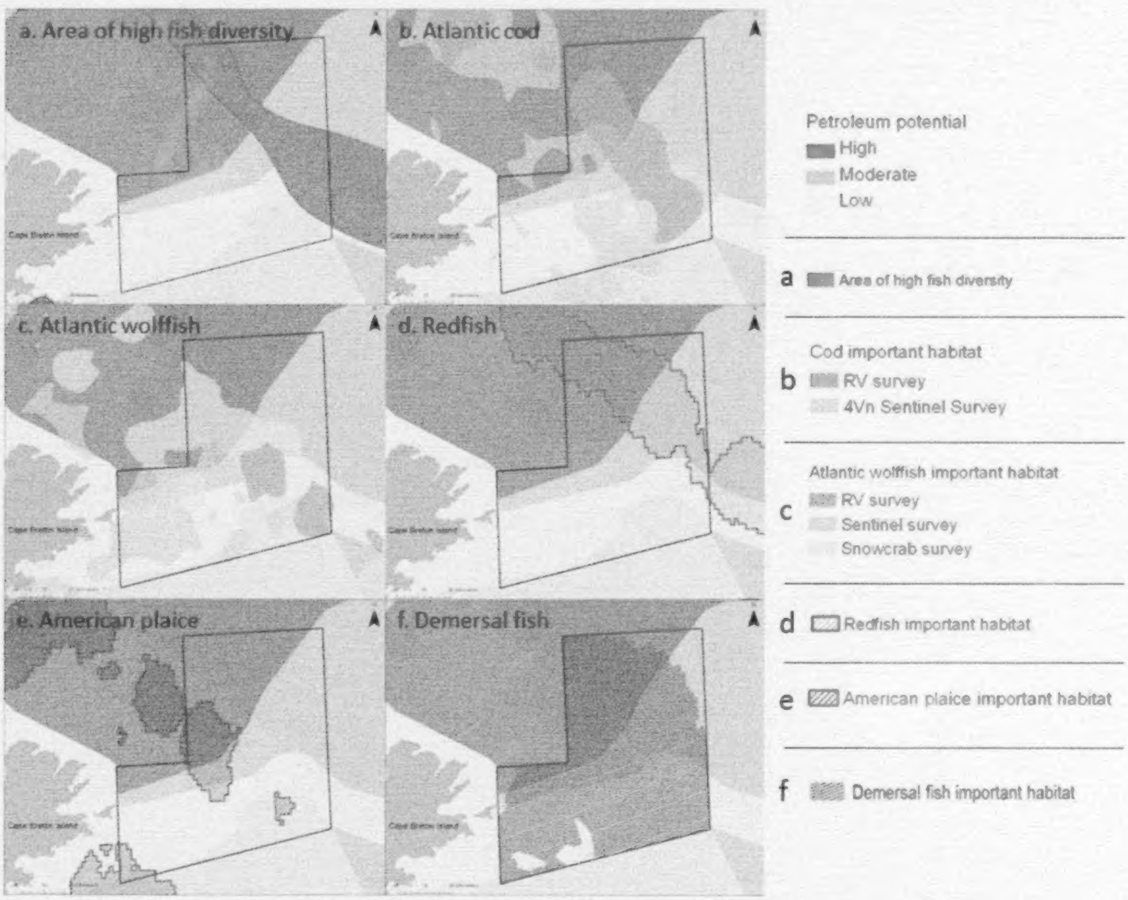

Figure 3.4.1 - 1. The overlap of potential oil and gas activity (adapted from Hannigan and Dietrich, 2012) with a) the area of high fish diversity, b) important Atlantic cod habitat, c) important Atlantic wolffish habitat, d) important redfish habitat and e) important American plaice habitat, and f) important habitat for demersal fish within the St. Anns Bank AOI (black polygon). Maps are adapted from Ford and Serdynska (2013).

While information on fish spawning activities in St. Anns Bank is incomplete, an inshore herring population was known to spawn in an area called the Big Shoal, just northeast of Scatarie Island (Power et al., 2010; Figure 3.4.1-2). Spawning for this herring stock occurs in fall (Stephenson et al., 2009). The resident populations of cod, wolffish, redfish and plaice may include spawning individuals and/or individuals migrating to nearby spawning grounds. Spawning activities for these species collectively spans April to December (as described in Section 1.5.1). The site also includes mating grounds for porbeagle shark (Ford and Serdynska, 2013). In general, fish eggs and larvae densities within the AOI can be expected to peak in the spring and summer, though spawning varies by species and eggs and/or larvae may be present year round (Locke, 2002).

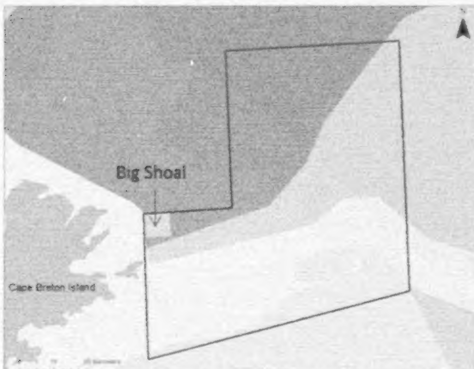

Figure 3.4.1 - 2. Overlap between areas of high (red), medium (orange), and low (yellow) prospectivity for oil and gas (adapted from Hannigan and Dietrich, 2012) with the herring spawning area within the St. Anns Bank AOI (black polygon).

Given that most of the area of high fish diversity and half or more of the important habitats for forage fish (including herring, capelin and mackerel), and demersal fish (including habitats for depleted species) overlap with areas of moderate or high petroleum potential, and the herring spawning area at Big Shoal is entirely within the area of high petroleum potential, the likelihood of an interaction between seismic activity and the conservation priorities related to fish was scored as high.

From the available literature, it appears that the earliest life stages are the most vulnerable to seismic noise. Specifically, studies have shown that very high levels of seismic noise can impact the development of fish eggs and larvae, and injury and mortality can occur from exposures within 5 metres of the air gun (Dalen et al., 2007; Payne, 2004). It has also been postulated that chronic (2-3 week) exposures to low levels of seismic sound may also be detrimental to important physiological functions in fish and shellfish (DFO, 2011d). While some have suggested that seismic operations have the potential to cause a reduction in year-class size if they coincide with times of the year when high densities of egg and larvae are in the water column, others have argued that even in such conditions only a small number of individuals would be exposed to damaging levels of seismic so no impacts on recruitment would be expected.

Effects of seismic noise have also been documented in adult fish. For example, hearing loss and damage to the hearing organs of adult fish have been reported in caged pink snapper exposed to repetitive air gun firing at noise levels equivalent to levels that would be experienced within 500m of a large seismic array (McCauley et al., 2003). However, similar studies on Atlantic Cod

exposed to varying intensities of seismic noise reported no immediate physical damage to hearing organs (Popper, 2006) and others have shown that the effects of seismic on hearing can vary by species (reviewed by Husky Energy, 2010). Behavioural responses, including startling and avoidance, have also been observed (Worcester 2006; Payne et al., 2008a; DFO, 2011d), and such effects have been reported as far as 20 nautical miles from the air gun source (Engås et al., 1996). The Statement of Seismic Practice (DFO, 2007b) outlines ramp-up requirements to minimize startle response and allow fish the opportunity to temporarily leave the area and avoid physical damages from seismic noise (Husky Energy, 2010). Additionally, the Statement of Seismic Practice requires that seismic surveys be planned to avoid significant population-level impacts to marine species, including energetically costly diversions of fish aggregations from known migration corridors, and the dispersion of aggregations of spawning fish from known spawning areas.

While the effects of seismic noise on fish are generally sub-lethal, there is potential for some localized impacts to eggs and larvae and behavioral disruptions including displacement from over-wintering grounds, and interference with mating, spawning and migration activities. These impacts are of particular concern for at-risk (e.g., porbeagle shark) and depleted species (e.g., cod) within the site. With the implementation of existing mitigation measures such as ramp up procedures and seasonal planning to avoid conducting surveys at peak times for spawning and migration, and when sensitive life stages are present, much of the potential impacts can be avoided. However, given that fish eggs and larval densities are expected to peak in the spring and summer months, spawning activities collectively span April to December, and the site is an overwintering ground for depleted Atlantic cod stocks, it may be difficult to plan a survey for a time of year when sensitive life stages/processes are not present. Because of this challenge, some residual impacts will be expected. Thus, to be precautionary, the consequence level was scored as medium. Taken together, a medium level of consequence combined with a high likelihood of interaction resulted in a **high** risk score for seismic noise exposure to fish within the St. Anns Bank AOI (Table 3.4.1-1). Given the paucity of available information on the presence of spawning or migrating fish, eggs and larvae within the site, uncertainties associated with the varying effects of seismic noise on different fish species, and uncertainties related to timing, location, and duration of a possible seismic program within the site, the certainty associated with this risk score was considered low.

Table 3.4.1 - 1. Risk of seismic activity to fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Invertebrates/ primary producers (structure forming/sensitive benthic species, benthic invertebrates, zooplankton and phytoplankton)

While available information is limited, the conservation priorities included in this category were considered to be distributed broadly across the AOI. Thus, the overlap between invertebrates and primary producers and oil and gas activities in the site was considered equivalent to the spatial

extent of the oil and gas prospectivity areas (i.e., 58% of the site). Thus, the likelihood of an interaction between seismic activity and the conservation priorities related to invertebrates and primary productivity was considered high.

Because invertebrates do not have swim bladders or hearing organs, the effects of seismic sound on adult invertebrates would generally be expected to be less severe than effects described for fish, and to date there is limited evidence to suggest impacts occur. Effects on benthic invertebrates are considered to be negligible in waters deeper than 20 metres (Royal Society of Canada, 2004). While very high levels of seismic sound have been shown to damage shellfish eggs and larvae within 5 metres of the source (Dalen et al., 2007; Payne, 2004; reviewed by DFO, 2011d), no effects were detected when Dungeness crab larvae were exposed to seismic noise generated from a seven airgun array at distances as close as 1 metre (Pearson et al., 1992; Payne et al., 2008b), and no changes in plankton distribution or concentration were reported in a field study that involved 38 days of 3D seismic activity (Løkkeborg et al., 2010). Some data suggests that lobsters subjected to seismic sound experience sublethal effects weeks to months after exposure, as indicated by changes in serum biochemistry and histochemical changes to the hepatopancreas suggestive of organ stress (Payne et al., 2007). However, studies of the impacts of seismic on snow crab have been inconclusive (reviewed in DFO, 2011d).

Overall, there is limited and somewhat conflicting evidence suggesting there are some detrimental effects of seismic noise on invertebrates/ primary producers. With mitigation in place to avoid conducting seismic surveys when sensitive life stages are in the water column (e.g., planktonic blooms in summer), the consequence score was considered low. With a high likelihood score and low consequence score, the overall risk of seismic activities to invertebrates and primary producers was scored as **medium** in the AOI (Table 3.4.1-2). However, given the limited and conflicting information on the impacts of seismic sound on invertebrates and uncertainties related to timing, location, and duration of a possible seismic program within the site, the level of certainty associated with this risk score was considered low.

Table 3.4.1 - 2. Risk of seismic activity to invertebrates / primary producers in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Leatherback turtles

Approximately half of the area identified as important habitat for leatherback turtles within the AOI is in the part of the site considered to have moderate or high petroleum potential (Figure 3.4.1-3). Leatherback turtles are present in the AOI between July and October, and use the area most heavily in August and September (James et al., 2006). During this summer foraging season, the likelihood of an interaction was considered high.

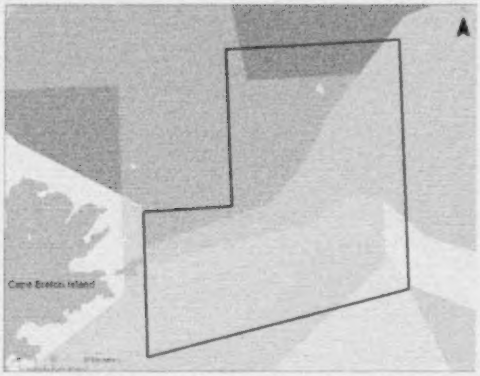

Figure 3.4.1 - 3. Overlap between areas of high (red), medium (orange), and low (yellow) prospectivity for oil and gas (adapted from Hannigan and Dietrich, 2012) with important habitat for leatherback turtle (green polygon; modified from DFO, 2012f) in the St. Anns Bank AOI (black polygon).

The impacts of seismic activity on sea turtles has only been studied for a few species, and the potential for physical effects is largely unknown (DFO, 2011d). Although little is known about sea turtles' sensitivity to sound, including seismic noise, some evidence suggests that turtles can detect and respond to sounds in the range of frequencies generated by seismic activities (Atlantic Leatherback Turtle Recovery Team, 2006). Studies have shown turtles caged within 500 metres of a seismic source to experience changes in hearing sensitivity, enzyme levels and white blood cell counts, and to increase swimming speed in response to the exposure (O'Hara and Wilcox, 1990; Moein et al., 1994, McCauley et al., 2000). Others have postulated that leatherback turtle hearing might be damaged by seismic noise exposure up to 3 km away from the source (Eckert et al., 1998). Several studies have also reported sea turtles exhibiting avoidance and increased surfacing behavior during seismic activities (e.g., Holst et al., 2006; Weir, 2007). Taken together, findings to date have raised concerns that seismic noise may displace sea turtles from preferred foraging areas (Atlantic Leatherback Turtle Recovery Team, 2006).

The limited available information suggests that sea turtles can hear and respond to seismic noise. However, while avoidance behaviour has been documented, the effects of seismic exposure remain largely unclear. The adoption of mitigation measures such as a minimum 30 minute ramp-up time to allow slow-swimming turtles to leave the area (Turnpenny et al., 2002) and the implementation of shut down procedures when a turtle is identified too close to the survey (DFO, 2007b), should help reduce the physical effects (e.g., hearing loss) of seismic exposure. Shut downs associated with the successful identification of leatherback turtles have occurred during a recently completed seismic survey, indicating that this mitigation measure has had some success (Shell Canada Ltd., 2013). However, because sea turtles are not easy to see and cannot be identified acoustically, the Atlantic Leatherback Turtle Recovery Team (2006) has expressed concerns that mitigation that relies upon the detection of individuals may not be entirely effective.

Because the AOI includes important summer foraging habitat for leatherback turtles, seismic surveys conducted at that time of year have the potential to displace these endangered animals from their foraging grounds as part of the avoidance reaction. As such the consequence level was scored as medium, and the overall risk of seismic noise exposure to leatherback turtles within the

St. Anns Bank AOI during summer foraging season received a **high** score in the AOI (Table 3.4.1-3). Of note, outside of the summer foraging season when leatherback turtles are not present in the site there is no interaction and thus no risk presented by oil and gas activities to this species. Given the limited information on the effects of seismic noise on leatherback sea turtles and uncertainties related to timing, location, and duration of a possible seismic program within the site, the certainty associated with these risk scores was considered low.

Table 3.4.1 - 3. Risk of seismic activity to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

d. Top predators (marine mammals)

As marine mammals are considered to be broadly distributed within the St. Anns Bank AOI, the overlap between marine mammals and oil and gas activities in the site was considered equivalent to the spatial extent of the oil and gas prospectivity areas (i.e., 58% of the site). Thus, the likelihood of an interaction between seismic activity and marine mammals was scored as high.

The highest energy sound output used in seismic surveys (10 to 200 Hz) overlaps with the frequency range of baleen whale vocalizations (<100 Hz) and hearing range (<1000 Hz) (Husky Energy, 2010; DFO, 2011d). Seismic airguns can also produce higher frequency sounds (up to 22 kHz) that overlap with the hearing and vocalization range of small toothed whales (0.5 to 20 kHz). The effects of seismic noise on marine mammals are not fully understood. While there have been no documented marine mammal mortalities associated with seismic activity, sublethal effects may include masking of conspecific sounds, increased stress levels, abandonment of important habitat, hearing damage, and alteration of migration, feeding, reproduction or immune responses (reviewed in DFO, 2011d). Some evidence suggests that pulsed sound can induce a temporary increase in hearing thresholds in captive marine animals under experimental conditions but no information is currently available on sound levels that cause permanent hearing damage (Husky Energy, 2010).

Studies have documented a range of behavioural responses in marine mammals exposed to seismic noise. While some studies have suggested that certain seal species (e.g., grey harbour and ringed seals) display detectable avoidance behavior in response to seismic sound exposure, trends are often confounded in these studies by individuals of the same species that demonstrated no detectable avoidance and remained within several hundred metres of the array (reviewed in LGL Ltd., 2005). Blue whales were found to vocalize more frequently during seismic surveys than when no surveys were underway, which may indicate efforts to compensate for the masking of conspecific sounds by seismic noise (Di Iorio and Clark, 2009). Spatial avoidance (small toothed whales, killer whales and baleen whales) and changes in orientation (long finned pilot whales) have also been reported during seismic surveys (Stone and Tasker, 2006). However, the biological significance of these responses has not been determined.

A variety of marine mammals, including endangered and threatened species, are known to use the St. Anns Bank AOI. While the impacts of seismic on marine mammals are poorly understood, the potential effects, including displacement of individuals of species listed under the *Species at Risk Act* that are engaged in migration or feeding in the area is cause for concern, especially if the seismic program is of long duration. As with leatherback turtles, physical impacts (e.g., hearing loss) can be minimized through the adoption of mitigation measures outlined in the Statement of Seismic Practice (DFO, 2007b), including the establishment of a safety zone within which no cetaceans shall be sighted for 30 minutes before starting a survey, the use of passive acoustic monitoring to detect the presence of cetaceans in low visibility conditions, and the employment of ramp-up procedures to allow marine mammals time to leave the area and shut down procedures for when a marine mammal is sighted too close to the survey. Additional operator commitments, such as the use of passive acoustic monitoring at all times during pre-ramp up and the extension of the observation period to 1 hour (LGL, 2013), would provide additional protection for deep-diving, cryptic animals like beaked whales. However, even with all of these measures in place, behavioral impacts, such as those associated with the masking of conspecific sounds, still present some concerns (Hilary Moors-Murphy, DFO scientist, personal communication). This is an issue particularly for species like blue whales, which are thought to communicate at low frequencies over very long distances (Richardson et al., 1995) and thus may be impacted by an intensive, multi-week seismic program even if they are not present in the immediate area. To be precautionary, a consequence score of medium was assigned.

With a likelihood score of high and a consequence score of medium, the overall risk of seismic activities to marine mammals was determined to be **high** in the AOI (Table 3.4.1-4). However, given limited information on the usage of St. Anns Bank AOI by various cetacean species, the outstanding questions regarding the effects of seismic noise on marine mammals, and uncertainties related to the timing, location, and duration of a possible seismic program within the site, the certainty associated with this risk score was considered low.

Table 3.4.1 - 4. Risk of seismic activity to marine mammals in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

3.4.2 Vessel and Drill Rig Lighting

Risk of Light from Exploratory Oil and Gas Activities to the Conservation Priorities

a. Fish [area of high fish diversity, forage fish, top predators (sharks), ichthyoplankton], invertebrates (pelagic life stages in zooplankton), primary producers and zooplankton

More than half of the important habitats for forage fish and most of the area of high fish diversity overlap with areas of moderate or high petroleum potential. Zooplankton and phytoplankton are considered to be broadly distributed across the site so the percentage overlap with areas of high or moderate oil and gas potential is equivalent to the spatial extent of those combined areas of

prospectivity (i.e., 58% of the AOI). Therefore, the likelihood of light from oil and gas exploration interacting with conservation priorities related to pelagic fish, invertebrates and primary producers was considered high.

Particularly at night, pelagic fish and plankton may be attracted to lights in the surface waters around drill rigs and vessels, creating concentrations of pelagic predators and prey that could result in increased predation (DFO, 2011d). However, any impacts on prey species would likely be localized and counteracted by benefits to predators. Thus the consequence score was determined to be very low. With a high likelihood and very low consequence, the overall risk of lights from exploratory oil and gas activities to pelagic life stages of fish, invertebrates and primary producers was determined to be **low** in the AOI (Table 3.4.2-1). However, given the lack of information on the effects of anthropogenic light from oil and gas activities on fish and plankton, the level of certainty associated with this risk score was considered very low.

Table 3.4.2 - 1. Risk of light from exploratory oil and gas activities to fish, invertebrates, primary producers and zooplankton in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Leatherback turtles

Approximately half of the area identified as summer foraging grounds for leatherback turtles within the AOI is considered to have moderate or high petroleum potential (Figure 3.4.1-4) so the likelihood of an interaction between leatherback turtles and light from oil and gas exploration was considered high. While turtles are likely aware of anthropogenic light from vessels and drill rigs, no detrimental effects of vessel and drill rig lighting to sea turtles are known (LGL Limited, 2010). Thus, the consequence was scored as very low, and the overall risk presented by light from exploratory oil and gas activities on leatherback turtles during the summer foraging season was determined to be **low** in the AOI (Table 3.4.2-2). Of note, outside of the summer foraging season when leatherback turtles are not present in the site there is no interaction and thus no risk presented by oil and gas activities to this species. Given uncertainties related to timing, location, and duration of oil and gas exploration programs within the site, and the lack of information on the effects of anthropogenic light from oil and gas activities on sea turtles, the level of certainty associated with this risk score was considered very low.

Table 3.4.2 - 2. Risk of light from exploratory oil and gas activities to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Top predators (marine mammals and seabirds)

As marine mammals and seabirds are assumed to be broadly distributed within the St. Anns Bank AOI, the percentage overlap with areas of high or moderate oil and gas potential within the site can be considered equivalent to the spatial extent of those combined areas of prospectivity; over 50% of the site. Altogether, the likelihood of light from oil and gas exploration interacting with marine mammals and seabirds was considered high.

While no effects of vessel and drill rig lighting have been identified for marine mammals (LGL Limited, 2010), seabirds are visually oriented and known to become disoriented at night when exposed to artificial light (Stantec Consulting Ltd., 2013), and anthropogenic light has been postulated to attract seabirds (e.g. storm petrels) to offshore drilling rigs (LGL Limited, 2010). Impacts include the potential for mortality from collisions with the seismic vessel, drill rig, or the flare (LGL Limited, 2010), the potential for birds to fly around the light source until exhausted (LGL Limited, 2005), and/or the disruption of migration patterns (Aubrecht et al., 2010). These impacts are of concern particularly at night or in low visibility conditions (i.e., fog), especially during migration periods (OSPAR Commission, 2007). However, with the implementation of existing mitigation, such as the down-shading and focusing of lighting on the work areas of offshore drill rigs to minimize seabird attraction, it is unlikely that anthropogenic light exposure would cause lasting effects on seabirds at the population level. As such, the consequence was scored as low. With a combined high likelihood and low consequence score, the overall risk of anthropogenic light on top predators (specifically seabirds) was scored as **medium** in the AOI (Table 3.4.2-3). However, given uncertainties related to timing, location, and duration of oil and gas exploration programs within the site, the lack of information on the effects of anthropogenic light from oil and gas activities on marine mammals, and the limited information on the usage of St. Anns Bank AOI by cetaceans, the level of certainty associated with this risk score was considered very low.

Table 3.4.2 - 3. Risk of light from exploratory oil and gas activities to top predators (marine mammals and seabirds) in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

3.4.3 Exploratory Drilling

After a seismic survey has identified potential hydrocarbon reserves, the next step in identifying and characterizing the resource is exploratory drilling (Hurley, 2009). These operations typically span several months, depending on the location of the reserve relative to the surface. While test wells were drilled in 1974 and 1976 to the northwest of the site (Figure 3.3-1), no drilling activity has occurred to date within the St. Anns Bank AOI, and there are currently no exploration licences that would allow for drilling within the site. However, should an exploration licence be awarded for the area and should the ensuing seismic program identify a potential reservoir, an exploratory drilling program could follow in a relatively short period of time.

Exploratory drilling imposes a variety of pressures that can negatively impact the marine environment. Pressures associated with this activity that have been assessed here are operational discharges (i.e., drill muds, cuttings), noise, and accidental spills and blowouts.

Unlike seismic surveys, which may cover large areas within the AOI, exploratory drilling is much more site-specific with primarily localized effects (i.e., particularly for drill muds and cuttings and noise). However, given the hypothetical nature of this assessment, it is impossible to predict where within the AOI a drill site might occur. Thus, it is acknowledged that the likelihood scores offered below, based on the spatial overlap of conservation priority areas with areas of high and moderate petroleum potential, are a vast over-estimate of the actual footprint of an actual exploratory drilling program. However, the spatial extent of the impacts were taken into consideration when assigning consequence scores.

Risk of Operational Discharges (i.e., drill muds and cuttings) to Conservation Priorities

As part of a strategic environmental assessment for oil and gas exploration in Misaine Bank, immediately south of the AOI, it was projected that exploratory drilling might result in "mounds tens of metres in diameter, smothering benthic organisms over an area of a few hundreds of square metres" (CEF Consultants Ltd, 2005, p. 89). This may describe a similar scenario for an exploratory drilling situation in the AOI. However, because drill waste accumulation is dependent upon oceanographic conditions such as currents and bottom stress (Hannah et al., 2006), modeling would be required to better predict the potential for the accumulation of drilling wastes discharged from hypothetical rigs located at various locations within the St. Anns Bank AOI. Accordingly, the assessment of the potential for impacts from operational discharges on St. Anns Bank conservation priorities is a precautionary analysis based on available literature on impacts reported in laboratory experiments, and/or in the field in other areas.

a. Fish [demersal fish in the area of high fish diversity, Atlantic cod, Atlantic wolffish, redfish, American plaice, demersal fish, forage fish (herring spawning area)]

As described above, most of the area of high fish diversity and half or more of the important habitats for demersal fish (including habitats for depleted species) overlap with areas of moderate or high petroleum potential (Figures 3.4.1-1a-f). Taken together, the likelihood of an interaction between operational discharges from drilling and the conservation priorities related to fish was scored as high.

Impacts from drilling operations, including smothering, organic enrichment, bioaccumulation and toxicity, pose the greatest threat to slow moving and immobile members of the benthic community (DFO, 2011d), and these impacts would apply to fish eggs laid on the seabed. Although part of the benthic community, adult demersal fish are generally considered to be less sensitive than benthic invertebrates to drilling-associated impacts, in part because their greater mobility serves to limit exposure levels. To date, there is little evidence to suggest that adult fish are negatively affected by exposure to drill muds and cuttings, despite the efforts of several environmental effects monitoring programs that included studies to detect health effects in fish located near drilling rigs (reviewed in DFO, 2011d). While some evidence for enzyme induction and histopathological effects have been reported in fish and fish larvae sampled close to rigs in the North Sea and Gulf of Mexico, these effects have been postulated to be in response to exposure to produced water from the sites, rather than from drill muds and cuttings. Taken together, although it is possible that drill muds and cuttings might smother fish eggs laid on the

seafloor, there is little evidence to suggest exposure to such discharges imposes any other physical or biochemical effects on fish. While the implementation of measures to avoid known benthic spawning areas (e.g., the herring spawning area at Big Shoal) would mitigate impacts, information about fish spawning and nursery areas within the site is extremely limited so some impacts to demersal eggs may still occur. Taken together, a consequence score of low was assigned.

With a high likelihood score and low consequence score, the overall risk of exposure to drill muds and cuttings to fish was scored as **medium** in the AOI (Table 3.4.3-1). However, given the limited information on the presence and location of demersal eggs and larvae within the site, the limited studies on the impacts of drill muds and cuttings on sensitive life stages of fish, and uncertainties related to timing, location, and duration of a possible drilling program within the site, the level of certainty associated with this risk score was considered low.

Table 3.4.3 - 1. Risk of operational discharges (drill muds and cuttings) to fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Invertebrates (structure forming/sensitive benthic species, other benthic invertebrates) and benthic habitats

As reviewed above (Section 3.4.1b), the conservation priorities in this grouping are considered broadly distributed across the AOI. As such, the percentage overlap with areas of high or moderate oil and gas potential within the site was considered equivalent to the spatial extent of those combined areas of prospectivity (i.e., 58% of the site). Thus, the likelihood of an interaction between operational discharges from drilling and the conservation priorities related to invertebrates was considered high.

The impacts of drilling-associated operational discharges of drill muds and cuttings are generally associated with slow moving and sessile benthic invertebrates (DFO, 2011d). Biological effects can include physical smothering, organic enrichment, bioaccumulation and toxicity from contaminants, and reduced growth and reproduction (i.e., from chronic exposure to certain drill mud compounds). While the rarely-used oil based muds are much more toxic than water- or synthetic based muds, low concentrations of oil-, low toxicity mineral oil-, synthetic- and water-based muds have all been shown to impact growth and reproduction in scallop (reviewed in DFO, 2011d). Given potential impacts to reproductive success, it has been postulated that exposure to drill muds has the potential to impact future year classes of scallop, depending on the drilling location, time of year, and distribution of scallop stocks in the area.

Additional concerns about the at sea disposal of synthetic-based muds focus on the potential to cause organic enrichment and the risks associated with the persistence of biodegradation products. As well, water-based muds and cuttings, which are produced in higher volumes than the other types, may cause increased turbidity and alter sediment texture. In a review of the environmental effects of exploratory drilling activities in Canada's offshore, Hurley and Ellis

(2004) found that in general, effects associated with drilling using either synthetic- or water-based muds were detectable within 1000 m of the drill site. Recovery of benthic communities (beyond the footprint of the cuttings pile) was generally reported to occur within 12 months after drilling had stopped.

The impacts of drilling-associated discharges on benthic invertebrate communities are relatively localized, but the potential exists for population-level effects for sensitive filter-feeders such as scallops. The implementation of existing mitigation measures, including a pre-spud survey to ensure avoidance of concentrations of slow-growing corals, would serve to limit the consequences of this activity, and recovery of affected communities generally occurs within a year of exposure. As such, the consequence score was considered medium.

With a high likelihood score and medium consequence score, the overall risk of exposure to drill muds and cuttings to invertebrates and benthic habitats was scored as **high** in the AOI (Table 3.4.3-2). However, given the limited information on the presence and location of sensitive benthic species and uncertainties related to location of a drilling program within the site, the level of certainty associated with this risk score was considered low.

Table 3.4.3 - 2. Risk of operational discharges (drill muds and cuttings) to invertebrates and benthic habitats in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

Risk of Drilling Noise to Conservation Priorities

a. Fish [area of high fish diversity, Atlantic cod, Atlantic wolffish, redfish, American plaice, demersal fish, forage fish, top predators (sharks)]

Because most of the area of high fish diversity and half or more of the important habitats for forage fish and demersal fish (including habitats for depleted species) overlap with areas of moderate or high petroleum potential (Figures 3.4.1-1a-f), the likelihood of an interaction between drilling noise and the conservation priorities related to fish was scored as high.

Information on the impacts of drilling noise on fish species is extremely limited. However, it has been postulated that continuous drilling noise could cause demersal fish to avoid an area up to 400 m from the source for prolonged periods (Jacques Whitford Environment Ltd., 2003; ICES 1995). As such, the potential exists for localized displacement from over-wintering grounds, and interference with mating, spawning and migration activities. Depending on the time of year that the drilling program occurs, these impacts could affect at-risk (porbeagle shark) and depleted species (cod, wolffish, redfish and plaice) within the site. However, given existing mitigation measures to avoid peak spawning times and areas, and the limited spatial extent of the affected area, impacts would be limited, and a consequence score of very low was assigned.

Taken together, a high likelihood of interaction combined with a very low level of consequence results in a **low** risk score for drilling noise exposure to fish within the St. Anns Bank AOI

(Table 3.4.3-3). However, given limited available information on the presence of spawning or migrating fish, and uncertainties related to the timing and location of a possible drilling program and the type of drilling rig to be used, the certainty associated with this risk score was considered low.

Table 3.4.3 - 3. Risk of drilling-associated noise to fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Top predators (marine mammals) and leatherback turtles

As marine mammals may be broadly distributed within the St. Anns Bank AOI, the percentage overlap with areas of high or moderate oil and gas potential within the site was considered equivalent to the spatial extent of those combined areas of prospectivity (i.e., 58% of the site is either considered to have moderate or high petroleum potential). As well, approximately half of the area identified as important habitat for leatherback turtles is in the part of the site considered to have moderate or high petroleum potential (Figure 3.4.1-4). Taken together, the likelihood of an interaction between drilling noise and both marine mammals and turtles was considered high.

Drilling-associated noise is quieter than seismic-sourced noise. However, there is still potential for drilling noise to interfere with vocal communications and to cause avoidance and displacement of individuals from important areas such as migration corridors and feeding grounds. No information was found characterizing the effects of drilling noise on turtles and limited available information on the effects of drill noise on seals suggests these animals are somewhat tolerant to this source of pressure. However, there is evidence to suggest that drilling noise negatively impacts some cetacean species (Richardson et al., 1995). Baleen whales in particular have been reported to avoid active drill sites. For example, bowhead whales displayed avoidance reactions between 10 and 20 km from drillship noises at predicted received levels as low as 115 dB, and gray whales responded to noises produced from a semi-submersible drill rig at received levels of ~ 120 dB, less than 1 km from the source (reviewed in LGL Limited, 2005). In contrast, humpback whales did not show signs of avoidance at similar received levels. While dolphins and other toothed whales such as long-finned pilot whales appear relatively tolerant of drilling noise, reactions from belugas are mixed – individuals exposed to playbacks of drilling sounds have displayed avoidance behaviour, but there are also reports of belugas swimming within 1600 m of a drillship (Richardson et al., 1995). In general, whales seem more responsive to drilling noise when the sound first starts or when the volume is increasing, while continuous drilling noise may lead to habituation for some species. Taken together, while drilling-associated noise has the potential to cause avoidance and displacement from important foraging grounds and migration routes, which is of particular concern for at risk marine mammals (e.g., blue whales) and leatherback turtles using the St. Anns Bank area, the extent of the displacement would be limited based on expected volumes, so the consequence score was determined to be low.

With a likelihood score of high and a consequence score of low, the overall risk of drilling-associated noise to leatherback turtles (during the summer foraging season when they are present in the site) and marine mammals was determined to be **medium** in the AOI (Table 3.4.3-4). However, given limited information on the usage of St. Anns Bank AOI by various cetacean species, the limited information regarding the effects of drilling noise on marine animals, and uncertainties related to the timing, location, and duration of a possible drilling program within the site and the type of rig to be used, the certainty associated with this risk score was considered low.

Table 3.4.3 - 4. Risk of drilling-associated noise to top predators (marine mammals) and leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

Risk of Accidental Spills and Blowouts to Conservation Priorities

The most significant potential risk associated with offshore drilling is from blowouts and spills. Coastal areas, such as the coast of Cape Breton, are more sensitive to oil spills than the open ocean (CEF Consultants Ltd, 2005), and there is potential for the predominant currents (see description in Ford and Serdynska, 2013) to transport hydrocarbons to shore. The probability of a blowout or large spill occurring is low. In the Gulf of Mexico, from 1979 to 1998, 0.6% of exploratory wells experienced uncontrolled flows or blowouts, and such events are generally less likely and better controlled now than in the past (API, 2009). Small, platform-based spills are not uncommon – CEF Consultants Ltd (2005) summarize spill incidents off Nova Scotia that were reported to the CNSOPB over 2002-2004, which included 57 minor (<1 m^3) spills, 2 moderate spills (1>10 m^3), and 2 significant spills (>10 m^3). Though rare, very large oil spills to do occur. In a review of environmental impacts of offshore oil and gas activities, DFO (2011d) reported that there have been five oil spills greater than 150,000 billion barrels in size in the history of offshore drilling. The recent Deepwater Horizon spill in the Gulf of Mexico in 2010 marks the 6th very large spill event.

While a variety of oil spill models are available to help predict the extent, trajectory, and impacts of an oil spill event, these tools cannot be used without more information about the type and location of the drill rig and the composition of hydrocarbon reserves (i.e., proportion of natural gas and light and heavier oils). Thus, the assessment of the potential for impacts from spills and blowouts on the St. Anns Bank conservation priorities was conducted with the precautionary assumption of a worst case scenario event (i.e., large quantity of oil released with widespread impacts).

a. Fish [area of high fish diversity, Atlantic cod, Atlantic wolffish, redfish, American plaice, forage fish, demersal fish, top predators (sharks)]

Conservation priorities relevant to fish species are collectively distributed broadly across the AOI. Most of the area of high fish diversity and half or more of the important habitats for forage

fish (including herring, capelin and mackerel) and demersal fish (including habitats for depleted species) overlap with areas of moderate or high petroleum potential (Figures 3.4.1-1a-f). Altogether, the likelihood of an interaction between operational discharges from drilling and the conservation priorities related to fish was scored as high.

Oil contaminants in surface waters have been shown to cause mortality, reduced or abnormal growth, and changes in biochemistry in fish (reviewed in DFO, 2011d). Further, exposure to oil contaminants at the seafloor may cause mortalities, and/or increased incidents of histopathology and susceptibility to disease in demersal fish species. The extent of the impacts would depend on the season, duration, and location of the event. In particular, if a large spill should occur at a time of year when eggs, larvae, and juvenile fish are present, the consequence particularly to at risk and depleted fish species would be high. Thus, the overall risk of a large spill or blow-out event to conservation priorities related to fish was scored as **high** in the AOI (Table 3.4.3-5). This score reflects the risk presented by the worst case scenario. The probability of a blowout or large spill occurring is low. Also, due to the limited available information on the impacts of oil contaminants on fish, and uncertainties related to the timing and location of a possible drilling program within the site and the composition of the potential petroleum reserves, the certainty associated with this risk score was considered low.

Table 3.4.3 - 5. Risk* of accidental spills and blow-outs to fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

*The risk presented here is based on a worst case scenario assumption. The probability of a blowout or large spill occurring is low.

b. Invertebrates (invertebrate zooplankton, benthic invertebrates, and sensitive benthic / structure forming species), primary producers and benthic habitats

The conservation priorities relevant to invertebrates, primary producers and benthic habitats are considered broadly distributed across the AOI. Thus, the percentage overlap with areas of high or moderate oil and gas potential within the site was considered to be equivalent to the spatial extent of those combined areas of prospectivity (i.e., greater than 50%). Thus, the likelihood of an interaction between an accidental spill or blowout and the conservation priorities related to invertebrates was considered high.

Similar to the impacts on fish, oil contaminants in surface waters may cause reduced or abnormal growth, changes in biochemistry, and mortality in invertebrate larvae (reviewed in DFO, 2011d). Exposure to oil contaminants at the seafloor may cause increased histopathology, susceptibility to disease, and mortality in benthic invertebrates. If a large spill or blow-out should occur at a time of year when invertebrate eggs or larvae are present, year class recruitment may be impacted. As such, the consequence of such an event was scored as medium. With a high likelihood and medium consequence score, the overall risk presented by a large spill or blow-out to conservation priorities associated with plankton and invertebrates was determined to be **high** in the AOI (Table 3.4.3-6). This score reflects the risk presented by the worst case scenario. The

probability of a blowout or large spill occurring is low. As well, due to the limited available information on the impacts of oil contaminants on invertebrates and primary producers, and uncertainties related to the timing and location of a possible drilling program within the site and the composition of the potential petroleum reserves, the certainty associated with this risk score was considered low.

Table 3.4.3 - 6. Risk* of accidental spills and blow-outs to invertebrates, primary producers and benthic habitats in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

*The risk presented here is based on a worst case scenario assumption. The probability of a blowout or large spill occurring is low.

c. Leatherback turtles

Approximately half of the area identified as important habitat for leatherback turtles within the AOI is considered to have moderate or high petroleum potential (Figure 3.4.1-4) so the likelihood of an interaction between leatherback turtles and light from oil and gas exploration was scored as high.

Sea turtles are particularly sensitive to oil spills because they do not show avoidance behavior to slicks, and take large inhalations (i.e., resulting in the potential for considerable uptake of petroleum vapours) prior to diving (NOAA, 2010a). Thus if these animals encounter a spill they are likely to experience extensive exposure. Oil exposure can interfere with olfaction and thus may interfere with their ability to navigate, skin exposure may cause inflammation and infection, and oil ingestion may cause changes in blood chemistry, organ failure, and mortality (NOAA, 2010a). Of note, over 600 sea turtles were found dead following the Gulf of Mexico oil spill in 2010 (NOAA, 2010b). Given the potential for lethal impacts on this endangered species, the consequence was scored as high.

With a high likelihood and high consequence score, the overall risk presented by a spill or blow-out to leatherback turtles during the summer foraging season within the St. Anns Bank AOI was scored as **high** in the AOI (Table 3.4.3-7). This score reflects the risk presented by the worst case scenario. The probability of a blowout or large spill occurring is low. Given the limited available information on the impacts of oil contaminants on leatherback turtles, uncertainties related to the timing and location of a possible drilling program within the site, and the composition of the potential petroleum reserves, the certainty associated with this risk score was considered low.

Table 3.4.3 - 7. Risk* of accidental spills and blow-outs to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

*The risk presented here is based on a worst case scenario assumption. The probability of a blowout or large spill occurring is low.

d. Top predators (marine mammals and seabirds)

As marine mammals and seabirds are assumed to be broadly distributed within the St. Anns Bank AOI, the percentage overlap with areas of high or moderate oil and gas potential within the site was considered equivalent to the spatial extent of those combined areas of prospectivity (>50% of the site), resulting in a high likelihood score.

Like leatherback turtles, marine mammals and seabirds can be exposed to oil through direct contact, inhalation and ingestion (Marine Mammal Commission, 2011). For marine mammals, physical contact to skin, eyes, and other mucus membranes can cause irritation, inflammation, and chemical burns, which in turn can increase the risk of infections. Oil exposure through inhalation can cause inflammation and emphysema, while ingestion can cause gastrointestinal inflammation, ulcers, diarrhea, malabsorption, maldigestion, intestinal bleeding, organ damage and reproductive impairments (Stantec Consulting Ltd., 2013; Geraci and St. Aubin, 1987). Baleen whales are especially susceptible to ingestion because oil can become trapped in the baleen and can contaminate food (Geraci and St. Aubin, 1987). While some reports suggest certain cetaceans are able to detect and avoid oil spills (Geraci and St. Aubin, 1987), other studies have found no evidence of avoidance or other protective behavioral changes in the presence of oil (Harvey and Dahlheim, 1994), making these species susceptible to prolonged exposure and associated consequences. For example, the Deepwater Horizon oil spill in the Gulf of Mexico resulted in the documented deaths of at least 154 dolphins and 3 other cetaceans (NOAA, 2013). Some have proposed these totals may be a considerable underestimate of the actual death toll, based on the estimate that an average of just 2% of carcasses might have been detected (Williams et al., 2011).

Seabirds are known to be attracted to offshore oil and gas platforms (reviewed in Weise et al., 2001), and these seabird aggregations are especially susceptible to the impacts of oil exposure during a spill or blow-out event. For seabirds, whose feathers readily absorb oil, oil exposure can cause reduced insulation, waterproofing, and buoyancy, which can lead to death due to hypothermia, exhaustion, or starvation (reviewed in Weise et al., 2001). Birds may also ingest oil during feather preening or by eating contaminated prey, which may lead to dehydration, malabsorption and maldigestion, reproductive impairment, and reduced survival. Because seabirds are long-lived and produced relatively few young, impacts from an accidental spill event on the local seabird population may affect population trends for years to come (Weise, 2002). If a spill were to occur during a time of year when large numbers of birds congregate while migrating, the population impacts could be felt at a global scale (Stantec Consulting Ltd., 2013).

Given the potentially lethal impacts to marine mammals (particularly to individuals of at risk species), and the potential for population-level impacts to seabirds, the consequences presented by an accidental spill or blow-out from exploratory drilling was scored as high. With a high likelihood score and a high consequence score, the overall risk presented by accidental spills and blowouts to marine mammals and seabirds was determined to be **high** in the AOI (Table 3.4.3-8). This score reflects the risk presented by the worst case scenario. The probability of a blowout or large spill occurring is low. While the impacts of oil spills on seabirds are well known, the impacts of oil spills on marine mammals are less well known. Additional uncertainties include the timing and location of a possible drilling program within the site, the composition of the potential petroleum reserves, and the limited information on the usage of St. Anns Bank AOI by various cetacean species. Thus, the certainty associated with this risk score was considered low.

Table 3.4.3 - 8. Risk* of accidental spills and blow-outs to top predators (marine mammals and seabirds) in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

*The risk presented here is based on a worst case scenario assumption. The probability of a blowout or large spill occurring is low.

3.5 Summary

The risks presented by exploratory oil and gas activities to the conservation priorities for the St. Anns Bank AOI were determined from available literature, and where appropriate consequence scores were assigned using precaution by considering the worst-case scenario (e.g., assume at risk cetaceans are present in the site and impacted by the activity under consideration). Risk scores are summarized in Table 3.5-1. Briefly, seismic activity was determined to pose high risk to fish (primarily due to impacts on at-risk and depleted species), leatherback turtles and top predators (primarily at-risk cetaceans). Anthropogenic light from vessels and drill rigs was determined to pose a medium risk to top predators (primarily seabirds). Exploratory drilling activities were determined to pose a high risk to benthic invertebrates from operational discharges (drill muds and cuttings), while drilling noise was classified as a medium risk to leatherback turtles and top predators (marine mammals). Accidental spills and blowouts associated with exploratory drilling were determined to pose a high risk to all conservation priorities. All risk scores assigned to exploratory oil and gas activities were associated with low or very low certainty scores primarily due to the limited available information on impacts, and uncertainties related to the timing, location, and nature of the hypothetical oil and gas exploration activities within the site. Note as well that throughout the exploratory oil and gas risk assessment, the large (>50%) area within the AOI used as the potential footprint for oil and gas activity resulted in a high likelihood score in every case. If the boundary of the AOI were to change to exclude some of the high prospectivity area, the likelihood scores and associated risk scores might be reduced in certain cases.

Table 3.5 - 1. Summary of risks presented by oil and gas exploration activities to conservation priorities for the St. Anns Bank MPA.

Conservation Priority	Risk Level	Certainty Level
Seismic surveys		
Fish	High	Low
Invertebrates and primary producers	Medium	Low
Leatherback turtles (during foraging season)	High	Low
Top predators (marine mammals)	High	Low
Light		
Fish (with pelagic life stages), invertebrates (pelagic life stages in zooplankton) and primary producers	Low	Very low
Leatherback turtles (during foraging season)	Low	Very low
Top predators (marine mammals and seabirds)	Medium	Very low
Exploratory drilling: operational discharges		
Fish (with demersal life stages)	Medium	Low
Invertebrates (benthic) and benthic habitats	High	Low
Exploratory drilling: noise		
Fish	Low	Low
Leatherback turtles (during foraging season) and top predators (marine mammals)	Medium	Low
Exploratory drilling: spills and blow outs[1]		
Fish	High	Low
Invertebrates, primary producers, and benthic habitats	High	Low
Leatherback turtles (during foraging season)	High	Low
Top predators (marine mammals and seabirds)	High	Low

[1] Spills and blowouts were assessed based on the worst case scenario. The probability of a blowout or large spill occurring is low.

4.0 MARINE TRANSPORTATION

4.1 Sector Overview

St. Anns Bank Area of Interest is located in a region with dense commercial vessel traffic, the majority of which is travelling between the St. Lawrence Seaway and the Eastern Seaboard of North America (Koropatnick and Aker, 2012). The main vessel classes that transit through the area are cargo, tanker and passenger vessels. There are slightly more vessel transits in the summer months than the winter months due to the reduction of Marine Atlantic Ferry transits and the closing of the St Lawrence Seaway (Marine Atlantic, 2012; Jenish, 2009). The vast majority of the passenger vessels in the area are the Marine Atlantic Ferries that travel between Cape Breton and Newfoundland. The average speeds of the vessels transiting through the area are between 12 to 14 knots for cargo and tanker vessels and between 16 to 18 knots for passenger vessels (Koropatnick and Aker, 2012).

The marine transportation sector has the potential to impact the environment in several ways. For example, vessels transiting the site could strike a whale or other large pelagic species that spend time in surface waters. Speed is a major factor contributing to the lethality of a vessel strike; in a study conducted in the Bay of Fundy on the impacts of vessel strikes on North Atlantic right whales (*Eubalaena glacialis*), it was determined that vessels travelling faster than 15 knots were more likely to result in a lethal collision (Vanderlaan et al., 2008). Given vessel transit speeds through the AOI average 16 to 18 knots, the potential exists for lethal strikes to occur within the site.

Transiting vessels also produce sound, which may impact species such as marine mammals that rely on the acoustic environment for communication, navigation, foraging, etc. (Merchant et al., 2012; Hatch et al., 2008; Clark et al., 2009; Williams et al., 2002). Sound levels and frequency ranges are generally determined by vessel size, class and transit speed (Richardson et al., 1995). Noise from vessel transits has the potential to mask whale sounds (Merchant et al., 2012). For example, blue whales communicate over long distances using low frequency sounds (ranging from 12-200 Hz) and up to 188 dB at source (Cummings and Thompson, 1971). Commercial shipping vessels produce sound in this low frequency range (i.e., less than 300Hz; Merchant et al., 2012).

Ambient noise in the marine environment from natural sources (e.g., from wind and waves) is approximately 20 Hz and between 35-75dB, but with the introduction of commercial shipping over the last century, the ambient noise levels in the marine environment have increased (Tyack, 2008). One study reported that cargo ships produced an average of 185.5 dB at source and an average of 144.9 dB at 3km distance from source, and tankers produced an average of 181 dB at source and 120.6 dB at 3km from source (McKenna, 2011). Areas that have a high vessel density can increase the impacts of vessel noise because sound is continually being input into the marine environment. In St. Anns Bank, one study estimated that sound levels frequently reach and exceed 120 dB within the AOI (Aker, 2012).

Vessel-sourced oily discharges and oil spills present another threat to the marine environment. Vessel-sourced discharges can include intentional releases of oily bilge water and fuel oil sludge (Koropatnick and Aker, 2012). Accidental spills can occur as a result of collisions, groundings, structural failure, or other unintentional instances of vessels in distress at sea. The severity of a spill would depend on the type of vessel involved (*e.g.*, an accident involving a cargo vessel

would produce a smaller spill than an accident involving an oil tanker carrying a full load of petroleum products), the weather conditions at the time of the spill, and the ability and timing of the spill response.

Another risk from vessel-sourced discharges is presented by ballast water exchange activities. Ballast water is water carried in tanks on board vessels that is taken up or discharged at port to ensure stability under varying loads (Koropatnick and Aker, 2012). Port-sourced water has the potential to carry organisms (i.e. aquatic invasive species) and diseases (i.e. cholera) from port to port. Currently, the best management for reducing the spread of invasive species is through ballast water exchange (McCollin et al., 2007). Ballast water exchange involves the replacement of low salinity port waters with high salinity offshore waters; this ensures that organisms taken up at a foreign port are removed from the ballast tanks in the offshore where they are less likely to survive. Ideally ballast water exchanges are conducted outside of Canada's 200 nm Exclusive Economic Zone, Alternative Ballast Water Exchange Zones have been identified within Canadian waters where vessels are permitted to conduct exchanges if logistical or safety reasons preclude exchanges further offshore. A seasonal (December 1 to May 1) Alternative Ballast Water Exchange Zone exists within the Laurentian Channel that overlaps with the northern extent of the St. Anns Bank AOI.

Existing mitigation

Operational discharges are regulated through Transport Canada's *Vessel Pollution and Dangerous Chemicals Regulations* (2012). In Canadian waters, vessels are prohibited from discharging oily bilge water that has an oil concentration greater than 15 ppm (*Vessel Pollution and Dangerous Chemicals Regulations*, 2012).

There has also been a phasing out effort in the global shipping industry of single hulled tankers. In Canada, all single hulled tankers are to be phased out by 2015 and replaced with safer, double hulled tankers, and all tankers operating in Canada that were built after 1996 have to be double hulled (*Vessel Pollution and Dangerous Chemicals Regulations*, 2012). Tankers are also required to form an agreement with a Response Organization before entering Canadian waters to set up a response plan in case of a spill event. Additionally, all vessels over 1000 GRT must have a certificate for the International Convention of Civil Liability for Bunker Oil Pollution Damage issued by the Flag State on proof of having insurance in place to cover any cost of cleanup in the event of a spill.

Ballast water exchange activity in Canadian waters is regulated through Transport Canada's *Ballast Water Management Control and Management Regulations* (2011). Under these regulations, vessels on transoceanic voyages[5] to a port, offshore terminal or anchorage area in the Great Lakes Basin, St. Lawrence River or Gulf of St. Lawrence that are unable to exchange their ballast offshore for safety reasons (e.g., due to severe weather conditions) are permitted to conduct an exchange in the Laurentian Channel Alternative Ballast Water Exchange Zone during the colder months of the year (December 1 – May 1), when the conditions are less favorable for foreign organisms to survive (Simard and Hardy, 2004).

[5] Voyages where vessels navigate more than 200 nm from shore in water depths of at least 2000 metres.

There are currently no mitigation measures in place for vessel strikes and vessel noise in the area.

4.2 Scope of the Marine Transportation Risk Assessment

For the purposes of this evaluation, three marine transportation-related activities will be assessed: vessel transits (noise and vessel strikes), oily discharges and spills, and ballast water exchange. Environmental effects of artificial light were addressed in the assessment of risks presented by oil and gas activities in the site (Section 3.0).

4.3 Methods

Potential for Interaction

The conservation priorities considered in the assessment of risk from the marine transportation sector included those related to fish and invertebrates (primarily pelagic life stages), and top predators (marine mammals and seabirds; Table 4.3-1). Specifically, the assessment examines the risk presented by vessel strikes to leatherback turtles and marine mammals, the risk of vessel noise to fish, leatherback turtles, and marine mammals, the risk of small oil spills to leatherback turtles, primary producers, zooplankton and top predators (especially seabirds), the risk of large accidental oil spills to all conservation priorities with pelagic life stages, and the risk of ballast water exchange to all ecosystem components.

Table 4.3 - 1. Potential for overlap between conservation priorities and marine transportation activities (transit, oil spills/discharges, and ballast water exchange). Dark blue shading indicates a known potential for interaction, light blue indicates an interaction may exist and white indicates no interaction.

Conservation Priority	Transit		Oil pollution		Ballast water exchange
	Strikes	Noise	Small Spills	Large Spills	
Habitat					
Benthic habitats					
Structure forming/ sensitive benthic species					
Biodiversity					
Area of high fish diversity					
Atlantic cod					
Atlantic wolffish					
Redfish					
American plaice					
Leatherback turtles					
Productivity					
Primary producers					
Zooplankton					
Benthic invertebrates					
Forage fish					
Demersal fish					
Top predators					

For the purposes of simplifying the analysis for marine transportation, some of the conservation priorities were grouped. For example, all conservation priorities related to fish were considered one grouping for the vessel transits and large accidental spill assessments. For small oil spills, primary producers and zooplankton (including ichthyoplankton) were assessed as one group. For large accidental spills, primary producers, invertebrate and all conservation priorities relevant for invertebrates with a pelagic life stage were grouped together. For the ballast exchange assessment, all conservation priorities were assessed as a group.

Likelihood levels

For the marine transportation risk assessment, relative levels of likelihood were determined by the spatial overlap between the conservation priorities and the area in which the activity under assessment was most likely to occur (Table 4.3-2). Specifically, for vessel transits and vessel-sourced oil pollution, an area encompassing the highest density of vessel traffic was used to define the spatial extent of the transit footprint in the site (Figure 4.4.1-1). For ballast water exchanges, the Alternative Ballast Water Exchange Zone in the Laurentian Channel was used to define the spatial extent of ballast water exchange activities in the site (Figure 4.4.3-1). It is important to note that this approach to estimating likelihood levels has limitations. Oil spills and the contents of ballast water may spread broadly from the source, so the spatial extent used in the assessment of these pressures may not adequately represent the extent of the impacts. As well, because the spatial approach to analyzing likelihood does not allow for the consideration of the probability of an event occurring, for cases where the event probability was low (e.g., large accidental oil spills), the worst case scenario was assessed, and the low probability of the event was acknowledge as a caveat to the assigned risk score.

Table 4.3 - 2. Likelihood definitions for the marine transportation risk assessment for St. Anns Bank.

Likelihood level (% overlap)	Definitions	
	Transits and accidental oil spills	Ballast exchange
Very low	< 1% of the conservation priority area overlaps with area of dense vessel concentration	< 1% of the conservation priority area overlaps with the alternative ballast exchange zone
Low	< 10% of the conservation priority area overlaps with areas of dense vessel concentration	< 10% of the conservation priority area overlaps with the alternative ballast exchange zone
Medium	10-50% of the conservation priority area overlaps with areas of dense vessel concentration	10-50% of the conservation priority area overlaps with the alternative ballast exchange zone
High	> 50% of the conservation priority area overlaps with areas of dense vessel concentration	> 50% of the conservation priority area overlaps with the alternative ballast exchange zone

Consequence levels

The consequences of marine transportation activities to the conservation priorities for St. Anns Bank were determined through literature review. The relative levels of consequence used in this assessment are defined in Table 4-3.3. Consequence levels were determined based on impacts to

local populations. In many cases, consequence level determinations were driven by considerations for impacts on at-risk and depleted species, as adverse impacts have more potential to affect these populations.

This assessment focused on the nature and distribution of activities and ecological features within the AOI boundaries, taking into account the conservation objectives for the proposed MPA. The consequence scores for marine transportation-related activities as determined through this exercise do not necessarily represent DFO's assessment of consequences for the same activities elsewhere in the Scotian shelf bioregion.

Table 4.3 - 3. Consequence definitions for the marine transportation risk assessment for St. Anns Bank.

Consequence level	Definition
Very low	Impacts are undetectable
Low	Impacts occur but recovery is rapid and there are no long term effects
Medium	Impacts occur and recovery is measured in months - 1 year
High	Impacts occur and recovery is measured in years - decades

Sources of information

The International Maritime Organization (IMO) requires all vessels over 300 gross tonnes and all passenger vessels carrying 12 or more passengers to carry an AIS transponder (Vanderlaan and Taggart, 2009). The AIS signal that is sent to the receiver carries information about the vessel that includes its tonnage, draft, length, destination, speed, type and location (Eide et al., 2007). The vessel data that were used to characterize vessel traffic within the St. Anns Bank study area were from an Automatic Identification System (AIS) receiver tower located in Glace Bay that is monitored by researchers in the Oceanography Department at Dalhousie University (Koropatnick and Aker, 2012).

Other information used to determine the consequences presented by marine transportation sector activities to the St. Anns Bank conservation priorities was obtained through a review of available literature.

4.4 Risk Assessment for Marine Transportation in St. Anns Bank AOI

4.4.1 Vessel Transits

For the purposes of this analysis, a vessel transit was defined as a single vessel passage through the study area. The main pressures associated with transits are vessel strikes and anthropogenic noise. Vessel traffic occurs within the entire AOI, however, it is mainly concentrated within the western portion (Figure 4.4.1-1).

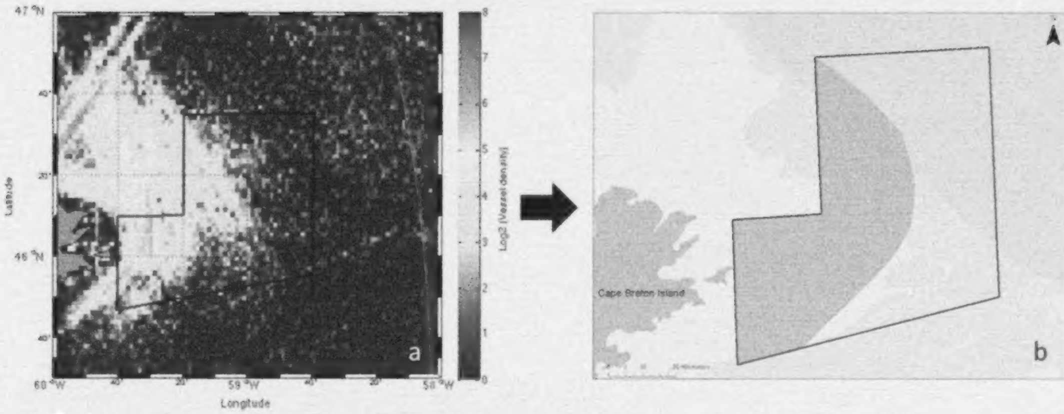

Figure 4.4.1 - 1. a) Vessel density within and around the St. Anns Bank AOI (black polygon) created from Automatic Identification System (AIS) data collected from Dalhousie University's Glace Bay receiving station. Vessel densities over a 12 month period (March to May 2010 and June 2011 to February 2012) were plotted in 0.03 degree grid squares using a $\log_2$ scale. b) The area of dense vessel traffic (blue polygon) within the AOI (black polygon). This area defined the extent of vessel transit activities within the site for the purpose of the assessment.

Risk of Vessel Strikes to Conservation Priorities

a. Leatherback turtles

The area of dense vessel traffic overlaps with over 50% of the important habitat for leatherback turtles within the AOI (Figure 4.4.1-2), which means the likelihood score for a vessel strike occurring when leatherback turtles are present in the area (i.e., during summer months) was considered high.

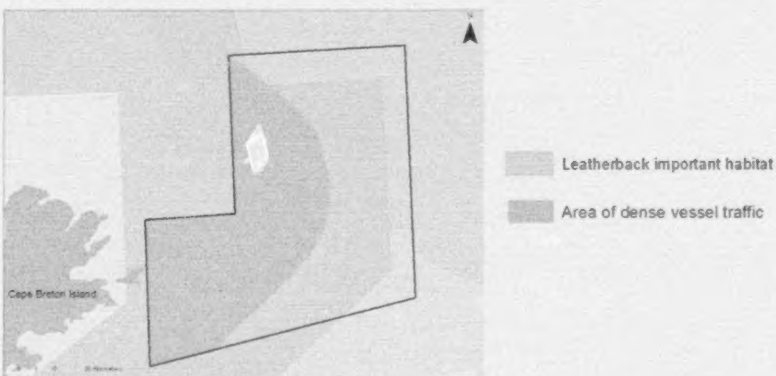

Figure 4.4.1 - 2. The spatial overlap between the area of dense vessel traffic and important habitat for leatherback turtles within the St. Anns Bank AOI (black polygon).

When leatherbacks are in northern waters off of Cape Breton, they feed on jellyfish and spend a considerable amount of time basking in sunlight at the surface; a means of retaining body heat in cold waters (Hays et al., 2006; James et al., 2005). Extended time at the surface makes leatherback vulnerable to vessel strikes. Specifically, small vessels are known to pose a strike

risk to leatherbacks (Eckert et al., 2009; DFO, 2012g). However, to date there is no evidence to suggest that large vessels pose a similar risk (Mike James, DFO scientist, personal communication), though it is speculated that leatherback turtles may still be disturbed or displaced by large vessels in transit through the site. Thus, a low consequence score was assigned. This resulted in an overall **medium** risk to leatherback turtles from vessel strikes in the AOI (Table 4.4.1-1). This risk is only present when leatherback turtles are in the AOI, from June to October. There was a very low level of certainty associated with this assessment because the impacts of large vessel interactions with leatherback turtles are not understood.

Table 4.4.1 - 1. Risk of vessel strikes to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Top predators (Cetaceans)

Whale species that are most commonly struck by vessels include humpback, fin and right whales (Laist et al., 2001). All three of these vessel-strike susceptible species may occur in the St. Anns Bank AOI, and humpback and fin whales are thought to be relatively common in the area (Ford and Serdynska, 2013). While fin and right whales may be present in the AOI during summer months, humpback whales may be found within the AOI year round (Ford and Serdynska, 2013).

Dense vessel traffic occurs in approximately 40% of the AOI (Figure 4.4.1-1). Since cetaceans are considered widely distributed throughout the AOI, the spatial overlap between cetaceans and marine vessel traffic was considered to be the extent of the dense vessel traffic area *(i.e.,* 40%). As such, a medium likelihood score was assigned.

To date, no incidents of vessel strikes on marine mammals have been reported in the St. Anns Bank area. However, according to Vanderlaan and Taggart (2007), vessels would have to travel at speeds lower than 11.8 knots in order to reduce the risk of lethality should a strike occur. Given that transit speeds through the AOI average 12-18 knots, if a strike were to occur, it would likely be a lethal event. As such, the consequence (particularly to endangered right whales) was determined to be high. Altogether, the overall risk of vessel strikes to cetaceans in the St. Anns Bank AOI was considered **high** in the AOI (Table 4.4.1-2). This risk should only be considered present when whales are in the area. For fin and right whales, this risk applies only to the summer months, while for humpback whales the risk is present year round. There was a low certainty level associated with this assessment based on the limited knowledge of the distribution and abundance of whale species in the AOI.

Table 4.4.1 - 2. Risk of a vessel strike to cetaceans in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

Risk of Vessel Noise to Conservation Priorities

a. Fish (i.e., area of high fish diversity, Atlantic cod, Atlantic Wolffish, redfish, American plaice, forage fish, demersal fish, top predators [sharks])

Fish, as a group, are considered to have a wide distribution throughout the AOI. As a result, the overlap between fish and the area of dense vessel traffic was considered equivalent to the high traffic area (*i.e.*, approximately 40% of the site), equating to a medium likelihood score.

While fish have been found to display a behavioural response to vessel noise in captivity (Kastelein et al., 2008), there is still very little known about the impacts of vessel noise in the natural environment. However some studies report that vessel noise can decrease hearing ability, induce stress and endocrinological responses, and cause displacement from high traffic areas (reviewed in Codarin et al., 2009). Furthermore, vessel noise has the potential to mask auditory communications of soniferous fish species (Codarin et al., 2009), such as gadids (*e.g.*, cod and haddock), which produce sound in the 80 – 500 Hz range during courtship and spawning (reviewed in Rountree et al., 2006). Given the potential behavioral impacts of vessel noise particularly to at-risk (porbeagle shark) and depleted species (cod, wolffish, redfish and plaice) in the site, a precautionary score of medium was assigned. This resulted in an overall **medium** risk from vessel noise on fish species in the AOI (Table 4.4.1-3). There was a low level of certainty associated with this assessment based on the limited available information of the impacts of vessel noise on fish and the unknown level of noise that occurs in the area.

Table 4.4.1 - 3. Risk of vessel noise to fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Leatherback turtles

The spatial overlap between dense vessel traffic and important habitat for leatherback turtles is greater than 50% (Figure 4.4.1-2), resulting in a high likelihood score.

There is little known about impacts of noise on leatherback turtles; however, some evidence suggests that vessel noise may displace turtles from their foraging areas and cause increased surfacing (O'Hara and Wilcox, 1990; Moein et al., 1994). As increased time at the surface could increase the chances of a vessel strike, and displacement from summer foraging grounds could be energetically costly to individuals of this endangered species, a medium consequence score

was assigned. Overall, the level of risk presented by vessel noise to leatherback turtles during the summer foraging season was considered to be **high** in the AOI (Table 4.4.1-4). There was a low certainty level associated with this assessment because the impacts of vessel noise on leatherback turtles are poorly understood.

Table 4.4.1 - 4. Risk of vessel noise to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Top predators (Cetaceans)

Cetaceans are considered to be broadly distributed across the AOI. As such, the area of dense vessel traffic within the site was also considered to be the area of overlap with cetaceans. Because this amounts to less than 50% of the site, a medium likelihood score was assigned.

Vessel noise has the potential to interfere with important cetacean life processes (Merchant et al., 2012; Hatch et al., 2008; Clark et al., 2009; Williams et al., 2002). For example, cetaceans are particularly sensitive to sound masking as many use sound to communicate with others, find mates, locate food, and navigate through the marine environment (Hatch et al., 2008). Vessel noise can also cause short term or chronic stress, shifts in attention, and behavioural changes such as alterations in communication frequency and amplitude (Merchant et al., 2012; Foote et al., 2004; Parks and Clark, 2007; Rolland et al., 2012). Of note, fin whales have been found to change their vocalization patterns to compensate for anthropogenic noise interferences when ambient sound reaches 120 dB or more (Castellote et al., 2010). Taken together, the consequence level was scored as medium, and the overall risk presented by vessel noise to cetaceans in the AOI was determined to be **medium** in the AOI (Table 4.4.1-5). There was a low level of certainty associated with this assessment due to limited information on the impacts of vessel noise on whales and limited knowledge of the distribution and abundance of whale species in the AOI.

Table 4.4.1 - 5. Risk of vessel noise to cetaceans in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

4.4.2 Vessel-Sourced Oil Pollution

Between April 1, 2007 and December 31, 2011, pollution surveillance flights conducted as part of the National Aerial Surveillance Program (NASP) investigated two spills (approximately 158 litres of oil spilled by an unknown source) that were detected within the boundaries of the St.

Anns Bank AOI. These spills were either accidental releases or intentional illegal discharges. Small, accidental spills may occur relatively frequently and may not always be detected through direct surveillance mechanisms (Weise and Robertson, 2004).

A large accidental oil spill event is a rare occurrence, but it may occur if a vessel experienced an accident (grounding, collision, sinking, etc.) and oil was released as a result of this event. The amount of oil released would depend on vessel type (e.g., an accident involving an oil tanker presents a larger risk than an accident involving a cargo ship). For the purposes of evaluating the potential for impacts on St. Anns Bank conservation priorities, a worst case scenario event (i.e., large quantity of oil released with widespread impacts) was considered.

Risk of Small Oil Spills to Conservation Priorities

a. Leatherback turtles

The spatial overlap between dense vessel traffic and important habitat for leatherback turtles is greater than 50% (Figure 4.4.1-2). Thus, the likelihood of a leatherback turtle exposure to small oil spills was considered high.

While exposure to large amounts of oil can be fatal to leatherback turtles (NOAA, 2010a), exposure to small quantities of oil would likely not cause long term impacts, resulting in a low consequence. This resulted in an overall **medium** risk from small oil spills on leatherback turtles during the summer foraging season in the AOI (Table 4.4.2-1). There was a low level of certainty associated with this assessment because of the limited information on impacts of oil exposure on sea turtles and uncertainties related to the location, quantity and frequency of small spills released in the AOI.

Table 4.4.2 - 1. Risk of small oil spills to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

b. Primary producers and zooplankton (including all pelagic fish and invertebrate eggs and larvae)

Primary producers and zooplankton are considered to be broadly distributed in the AOI. As the area of dense vessel traffic covers approximately 40% of the site, the likelihood of small oil spill exposure to primary producers and zooplankton in the site was scored as medium.

Oil contaminants in surface waters may cause reduced or abnormal growth, changes in biochemistry, and mortality in fish and invertebrate larvae (reviewed in DFO, 2011d). However, oil can disperse relatively rapidly in the environment through weathering, and many planktonic organisms have a rapid rate of regeneration. Thus, unless the spill is large, population-level impacts would not be expected, so the consequences were considered to be low. This resulted in an overall **low** risk from small oil spills to primary producers and zooplankton within the AOI (Table 4.4.2-2). There was a low level of certainty associated with this assessment based on the

limited information on the impacts of oil on planktonic species and uncertainties related to the location, quantity and frequency of small oil spills in the AOI.

Table 4.4.2 - 2. Risk of small oil spills to primary producers and zooplankton in the AOI.

Consequence		Likelihood: Very low	Low	Medium	High
	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

c. Top predators

Cetaceans passing through small volumes of oil in the area will not likely experience extensive exposure so long term health impacts would not be expected. However, seabirds are particularly susceptible to the detrimental effects of oil exposure, and thus are the focus of this assessment.

Seabirds are considered to have a wide distribution across the AOI. Because the area of dense vessel traffic covers approximately 40% of the site, the likelihood of seabirds being exposed to small oil spills was scored as medium.

Even small spills can have large impacts on seabirds. For example, there have been many cases where the only evidence of small spills is that oiled birds wash up on shore (Weise and Robertson, 2004). Weise (2002) estimated that approximately 300,000 seabirds are killed each year from oiling in the marine environment caused by accidental spills and illegal discharges in Atlantic Canada. Since this report was published, the number of oiled birds found in beached bird surveys in Newfoundland has declined, however the densities of oiled birds are still higher in the Newfoundland region than in other parts of the world (Wilhelm et al., 2009).

When birds come in contact with oil their feathers lose their waterproofing ability, resulting in reduced insulation and buoyancy, which can lead to death due to hypothermia, exhaustion, starvation, and increased vulnerability to predators (International Bird Rescue, 2013; Weise et al., 2001). Seabirds are long lived species that only produce a small number of eggs in a year, so the loss of adult seabirds from exposure to oil from vessel discharges and accidental spills can have long-lasting impacts at the population level (Weise, 2002), resulting in a high consequence score. The overall risk to seabirds from small oil spills was considered to be **high** in the AOI (Table 4.4.2-3). There was a moderate level of certainty associated with this assessment based on the knowledge of the impacts of oil spills on seabirds.

Table 4.4.2 - 3. Risk of small oil spills to seabirds in the AOI.

Consequence		Likelihood: Very low	Low	Medium	High
	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

Risk of Large, Accidental Oil Spills to Conservation Priorities

a. Fish (i.e., area of high fish diversity, Atlantic cod, American plaice, forage fish, demersal fish)

Fish, as a group, are considered to have a wide distribution across the AOI. As the area of dense vessel traffic covers approximately 40% of the site, the likelihood that fish would be exposed to a large accidental spill (assuming one occurs) was scored as medium.

As discussed above, oil exposure can affect growth, influence biochemistry, and cause mortality in fish larvae (reviewed in DFO, 2011d). If a large accidental spill occurred at a time when there were eggs, larvae and juvenile fish in the water column, the consequence, particularly to at-risk and depleted fish species, would be high. Altogether, the risk of a large oil spill event to fish was determined to be **high** in the AOI (Table 4.4.2-4). Note that this score reflects the risk presented by the worst case scenario. The probability of a large accidental oil spill occurring is low. There was a low certainty level for this assessment due to the limited available information on the impacts of oil contaminants on fish.

Table 4.4.2 - 4. Risk* of a large accidental oil spill to fish in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

*The risk presented here is based on a worst case scenario assumption. The probability of a blowout or large spill occurring is low.

b. Leatherback turtles

The area of dense vessel traffic overlaps with more than 50% of the important habitat for leatherback turtles within the AOI (Figure 4.4.1-2), resulting in a high likelihood that turtles would be exposed to a large accidental spill if one should occur in the site during the summer foraging season.

Sea turtles are particularly sensitive to large oil spills because they do not show avoidance behavior to slicks, and are known to take large inhalations prior to diving, exposing them to large volumes of petroleum vapours (NOAA, 2010a). Sea turtles exposed to oil can suffer from skin inflammation and infection, while oil ingestion may cause changes in blood chemistry, organ failure, and death (Shigenaka et al., 2010; Lutcavage et al., 1995). Oil exposure can also cause disorientation as it can interfere with olfaction, which turtles rely upon for navigation and orientation (NOAA, 2010a). Over 600 sea turtles were found dead following the major spill event in the Gulf of Mexico in 2010 (NOAA, 2010b). Thus, the consequence of a leatherback turtle coming in contact with large amounts of oil was considered to be high. This resulted in an overall **high** risk of a large oil spill event to leatherback turtles during the summer foraging season when they are present in the site (Table 4.4.2-5). Note that this score reflects the risk presented by the worst case scenario. The probability of a large accidental oil spill occurring is low. There was a low level of certainty associated with this assessment due to limited information about the impacts of oil on leatherback turtles.

Table 4.4.2 - 5. Risk* of a large accidental oil spill to leatherback turtles in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

*The risk presented here is based on a worst case scenario assumption. The probability of a blowout or large spill occurring is low.

c. Primary producers and invertebrates (including invertebrate zooplankton, and benthic invertebrates and sensitive benthic invertebrates with pelagic life stages)

Conservation priorities included in this group are considered broadly distributed across the AOI. Because the area of dense vessel traffic covers approximately 40% of the site, there was a medium likelihood that primary producers and zooplankton would be exposed to a large accidental spill should one occur in the site.

As discussed above, oil in the marine environment can have lethal effects on planktonic organisms, including invertebrate eggs and larvae (DFO, 2011d). If a spill occurs during a planktonic bloom when sensitive life stages are present in high numbers, impacts might be detectable at the local population level (DFO, 2011d). As such, the consequence of such an event on planktonic species was considered medium. Taken together, the risk of a large accidental oil spill to primary producers and zooplankton was determined to be **medium** in the AOI (Table 4.4.2-6). Note that this score reflects the risk presented by the worst case scenario. The probability of a large accidental oil spill occurring is low. There was a low level of certainty associated with this assessment based on the limited available information of the impacts of oil on invertebrates and primary producers.

Table 4.4.2 - 6. Risk* of a large accidental oil spill to primary producers and zooplankton in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

*The risk presented here is based on a worst case scenario assumption. The probability of a blowout or large spill occurring is low.

d. Top predators (seabirds and marine mammals)

Seabirds and marine mammals are assumed to have a wide distribution across the AOI. Since the area of dense vessel traffic covers approximately 40% of the site, seabirds and marine mammals were assigned a medium likelihood of exposure to a large oil spill event if one should occur in the site.

As reviewed in the Oil and Gas risk assessment (Section 3.0), for marine mammals, physical contact with oil can cause inflammation, chemical burns, and infection, while inhalation and ingestion can cause inflammation, hemorrhage of the lungs or intestinal lining, reduced nutrient absorption, organ damage, reproductive impairments, and death (Geraci and St. Aubin, 1987). Baleen whales are especially susceptible to ingestion because oil can become trapped in the baleen and can contaminate food.

Behavioral changes in marine mammals vary; some studies have reported that marine mammals show no behavioural response to the presence of oil (Harvey and Dahlheim, 1994), while laboratory studies have shown that bottlenose dolphins can detect and avoid oiled areas (Geraci and St. Aubin, 1987). As such, some cetaceans may be more susceptible to prolonged exposure and related impacts. For example, during the aftermath of the 1989 Exxon Valdez spill, grey whales were found swimming through heavily oils areas (Harvey and Dahlheim, 1994). Subsequently, 25 grey whale carcasses were found, in addition to 1 fin whale, 2 minke whales, 7 harbour porpoises and 3 unidentified whales (Geraci, 1990).

Also as discussed above, seabirds are especially susceptible to oil contamination. Oil exposure reduces the waterproofing and insulative properties of the feathers which can result in beaching, drowning, hypothermia and death (Clark, 1984). Oiled birds will also preen to try and remove oil, resulting in ingestion, which could lead to dehydration, a reduction in nutrient absorption and developmental delays, reproductive impairment, and mortality (Clark, 1984; Weise et al., 2001). It was estimated that 250,000 seabirds were killed as a result of the Exxon Valdez oil spill (Piatt and Ford, 1996). Based on the potentially lethal and lethal effects of oil on whales and seabirds, respectively, the consequence score was determined to be high. This resulted in an overall **high** level of risk from oil spills to top predators in the AOI (Table 4.4.2-7). Note that this score reflects the risk presented by the worst case scenario. The probability of a large accidental oil spill occurring is low. There was a low level of certainty associated with this assessment because the impacts of oil spills on marine mammals are not well known, and information on the usage of St. Anns Bank AOI by various cetacean species is limited.

Table 4.4.2 - 7. Risk* of a large, accidental oil spill to top predators (marine mammals and seabirds) in the AOI.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

*The risk presented here is based on a worst case scenario assumption. The probability of a blowout or large spill occurring is low.

4.4.3 Ballast Water Exchange

Simard and Hardy (2004) identified areas within the Gulf of St. Lawrence and Laurentian Channel that were at risk of invasive species introductions from ballast exchanges in spring and late summer. St. Anns Bank was not identified as an area of risk in that report. As well, ballast exchanges conducted within the deeper waters of the Laurentian Channel have been identified as

posing a negligible risk as compared to exchanges conducted in other parts of the Gulf of St. Lawrence (RNT Consulting Inc., 2002; Claudi and Ravishankar, 2006).

The Laurentian Channel Alternative Ballast Water Exchange Zone (Figure 4.4.3-1) allows for ballast water exchanges to occur in waters deeper than 300 m between December 1 and May 1 of each year. The area of permissible ballast exchange within the AOI is approximately 1250 km^2, equating to 24.5% of the AOI.

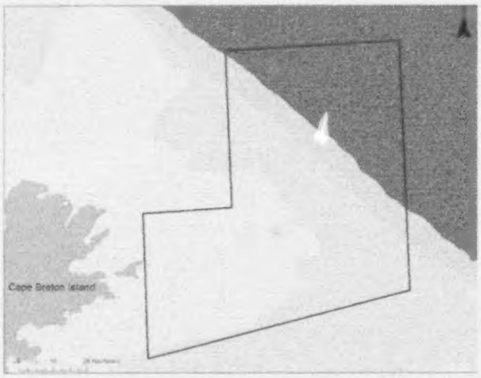

Figure 4.4.3 - 1. The Laurentian Channel Alternative Ballast Water Exchange Zone (blue area) within the St. Anns Bank AOI (black polygon).

Risk of Ballast Water Exchange to Conservation Priorities

If a species was introduced into the AOI and became established, it may out-compete native species for habitat and resources (IUCN, 2009). This, in turn, may have broader impacts on the entire ecosystem of the AOI. Because it is difficult to predict which components of the ecosystem would be most impacted by an invasive species introduction without knowing more about the species, risks presented by ballast water exchanges were restricted to a broad examination of the St. Anns Bank ecosystem as a whole.

The area of permissible ballast exchange within the AOI is approximately 25% of the site, so the likelihood of ballast water exposure to ecosystem components within the St. Anns Bank AOI was scored as medium. It is important to note that this Alternative Ballast Water Exchange Zone is used rarely during the permissible season (December 1 – May 1). When it is used, it is not likely that all ballast tanks would be exchanged in the area. So while the spatial overlap of the alternative exchange zone results in a medium likelihood, the probability of exchanges actually occurring in the area is low.

Impacts of a successful invasive species introduction could be detrimental to the entire ecosystem. However, with existing mitigation, such as the seasonality (winter months only) of the permissible ballast exchange zone and the allowance of exchanges only in deeper, high salinity waters of the Laurentian Channel, survival of foreign coastal species is very unlikely. As such, even if a foreign species is released in ballast water within the site (i.e., worst case scenario), a successful establishment would not be expected in the AOI (Simard and Hardy, 2004). Thus, the consequence of ballast water exchange events within the AOI was considered to be very low. This resulted in an overall **low** risk of ballast exchanges to ecosystem components within the St. Anns Bank AOI (Table 4.4.3-1). There was a moderate level of certainty associated with this assessment based on available scientific advice (Simard and Hardy, 2004).

Table 4.4.3 - 1. Risk of ballast water exchange to the St. Anns Bank AOI ecosystem.

		Likelihood			
		Very low	Low	Medium	High
Consequence	Very low	Very low	Very low	Low	Low
	Low	Very low	Low	Low	Medium
	Medium	Low	Low	Medium	High
	High	Low	Medium	High	High

4.5 Summary

The key risks presented by the marine transportation sector to the conservation priorities for the St. Anns Bank AOI are summarized in Table 4.5-1. For the assessment presented here, consequences were generally determined from available literature and, where appropriate, scores were assigned using precaution by considering the worst-case scenario (e.g., assume activity under consideration occurs during a time of year when at risk or depleted species are present in the site). Using this approach, vessel strikes were determined to pose a medium risk to leatherback turtles and a high risk to marine mammals. Vessel noise was found to present a medium level of risk to marine mammals and fish, and a high risk to leatherback turtles during their summer foraging season. Small oil spills were determined to pose a medium risk to turtles and high risk to top predators (primarily seabirds), and larger accidental spills posed medium to high risks to all conservation priorities. With existing mitigation as prescribed by Canada's *Ballast Water Control and Management Regulations* (2011), ballast exchange activities were determined to pose a low risk to the conservation priorities for the site.

Table 4.5 - 1. The summary of the risk and certainty scores associated with each assessment for the marine transportation sector.

Conservation Priority	Risk Level	Certainty Level
Vessel strikes		
Leatherback turtles[1]	Medium	Very low
Top predators (marine mammals)	High	Low
Vessel noise		
Fish	Medium	Low
Leatherback turtles[1]	High	Low
Top predators (marine mammals)	Medium	Low
Small oil spills		
Leatherback turtles[1]	Medium	Low
Primary producers, zooplankton, and benthic invertebrates	Low	Low
Top predators	High	Moderate
Large oil spills[2]		
Fish	High	Low
Leatherback turtles[1]	High	Low
Primary producers, zooplankton, and benthic invertebrates	Medium	Low
Top predators (marine mammals and seabirds)	High	Low
Ballast water exchange		
All conservation priorities	Low	Moderate

[1]Risk only present in summer months when leatherbacks are present.

[2]Large oil spill assumed to have occurred; such events would be rare.

5.0 SUMMARY AND NEXT STEPS

The ecological risk assessment of the St. Anns Bank AOI was conducted to establish the relative risk presented by interactions between the conservation priorities for the future MPA and human activities that occur (or may occur in the near future) in the area. In general, risk score determinations were limited by available knowledge and data for the area. With better information for activities and conservation priorities in the site, some scores may have been altered. As well, because this assessment was conducted with an MPA as its focus, impact tolerance was lower than it would be for areas not set aside for conservation purposes. Thus, the risk scores reported here may not represent DFO's assessment of risks for the same activities elsewhere on the Scotian shelf.

For the St. Anns Bank risk assessment, likelihood was strictly defined as the percentage of spatial overlap between the activity to be assessed and the spatial extent of each conservation priority. This spatial approach to analyzing likelihood was a limitation in the method. It does not allow for the consideration of the probability of an event occurring, so assessments had to be conducted based on the worst case scenario (i.e., risk was determined based on the assumption that the event would occur). For cases where the probability of an event was low but the spatial extent of the effect was large (e.g., large oil spill due to an accident related to shipping or exploratory drilling), a high likelihood score had to be assigned, and the resultant risk score was also higher than might otherwise be expected. To address this limitation in these cases, the low probability of the event was acknowledged as a caveat to the assigned risk score. Going forward, it is recommended that both probability and spatial overlap be considered when defining likelihood levels for site-specific risk assessment processes. Meanwhile, as a general practice, probability is taken into consideration for decision-making related to MPA site management for all MPAs, including the future St. Anns Bank.

The findings of this work have contributed to decision-making about activities that will be allowed under the regulations within the future MPA, and have also helped to inform the design of the final boundaries and zones where certain activities will be permitted. For example, some activities that received mostly high risk scores, such as redfish otter trawl, will be excluded from the MPA, while activities that produced mixed risk scores, such as pot fisheries and halibut longline, will be provided access only in specific locations, and with additional monitoring requirements. As well, much of the high oil and gas prospectivity area identified by Hannigan and Dietrich (2012) has been excluded from the proposed MPA boundary, so some of the risks presented by oil and gas exploration in the final MPA should be reduced. While the marine transportation sector will not be restricted under the proposed MPA regulations, on-going monitoring is planned to ensure existing management measures are adequate to protect conservation priorities from risks presented by transportation-related pressures.

It must also be noted that the findings presented here are not prescriptive and do not represent final decisions about how activities will be managed. Rather, the assessment provides a structure for considering information about the ecological effects of activities in a systematic manner to help inform discussions and decisions. Other factors, including the precautionary approach, current reliance on the area, and DFO's management experience and knowledge of the site have also been taken into account in determining final design and management measures.

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